



Education &
Communities

Use of Tablet Technology in the Classroom

NSW Curriculum and Learning Innovation Centre

A Partnership between Sydney Region and the NSW Curriculum and Learning Innovation Centre



Phase 1 iPad Trial

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Executive Summary

Origins and Purpose of the Evaluation

Sydney Region has sought to provide schools with evidence-based information regarding the use of iPads in the classroom. The Region purchased 75 iPads and distributed them to 3 primary schools during semester 2 2011. A partnership was then formed with the NSW Curriculum Learning and Innovation Centre (CLIC) to scope an evaluation of their use. Key focus areas for this evaluation were:

- providing information to schools to allow informed purchasing decisions
- identifying critical ramifications of tablet technologies on teaching and learning
- identifying appropriate opportunities for professional learning for teachers

Another, less significant focus was ascertaining parent questions and concerns about young students' use of mobile touch devices in out-of-school contexts.

Background and Objectives

Mobile touch-screen technologies, also referred to as tablet technologies, have introduced a new generation of educational tools that afford creative use and instant access to a wealth of online resources. They have been touted as 'revolutionary' devices that hold great potential for transforming learning.

One of the chief benefits of mobile devices is that they enable learning anywhere, anytime. This allows a shift away from the industrial era model where the classroom is the central place of learning driven by the teacher and limited to instruction within the school day. In deploying mobile devices, the teacher is no longer at the centre of the learning process and the instructional time can transcend the school day.

The portability of mobile devices provides users with access to a broader and more flexible source of learning materials than what is offered in current classroom settings. With over 500 000 apps (mobile applications) available to download from the App Store teachers have access to an abundance of learning materials for use on mobile devices such as the iPad.

There is emerging evidence to suggest that apps have a significant potential to support the learning process (Shuler, 2012). However, to date, there is a paucity of research to confirm that assertions about tablet technologies are actualised in real classroom settings. Limited research has been conducted on young students' use of touch screen devices and their educational impact. Research has also failed to keep pace with the emergence of apps despite an 'app culture' emerging since the inception of the iPhone in 2007 (Purcell, Entner & Henderson, 2010; The NPD Group, 2010). There is a dearth of empirical evidence to confirm that educational apps are valuable for learning despite the preponderance of apps marketed as 'educational' (Shuler, 2012).

This evaluation seeks to provide evidence-based information about the practical and technical implications of deploying mobile devices (iPads) in classroom environments and their subsequent impact on teaching and learning. In addition, it explores students' and teachers' perceptions and use of mobile devices and provides a systematic analysis and classification of educational apps. It seeks to contribute to the emerging body of literature on the effective implementation of tablet technologies in classroom settings.

In order to address the inadequacies in the existing corpus of research and tackle the lack of practical information about implementing mobile devices in school settings, Sydney Region conducted an iPad trial. This evaluation reports the findings of this trial, conducted in 2011 in Terms 3 and 4 in three primary schools in the Sydney region. The trial period included approximately eighteen weeks of instructional time with the iPads. The genesis of this trial was the desire expressed by many schools in the Sydney Region and many other areas of New South Wales to implement iPads into their schools. Many schools have purchased significant numbers of iPads and other mobile devices without being aware of the deployment implications or pedagogical ramifications. The objective of this trial was to provide consistent advice regarding:

- (i) The implications of mobile devices for teaching and learning; and
- (ii) The technical and logistical procedures for effective deployment and management of the devices in school settings, primarily NSW Department of Education and Communities (DEC) schools.

Methodology

A qualitative research study was conducted with three schools, five teachers, over 90 students and 75 iPads were used. A mixed method approach was implemented with a multi-setting case study comprising the data set. Multiple data sources were used to provide descriptive information about the technical and logistical enactment of iPads and to identify the implications for teaching and learning. A comprehensive data set was provided: lesson observations of the iPads in use, teacher and student online surveys; teacher, student, principal and parent semi-structured interviews; digital work samples; teacher and student blogs; and an 'app matrix'. After repeated viewings of the multiple data sources, the evaluator identified recurring themes which were recorded in a theme matrix.

Key Findings

Considering the small sample size and brief duration of the trial, readers are cautioned against generalising or interpreting the findings as policy recommendations. However, this evaluation provides important insights into how one type of mobile device, an iPad, was deployed and utilised in primary classrooms and their impact on teaching and learning. It is anticipated that this document will provide evidence-based information and guidance on how to best plan for and implement iPads in NSW DEC primary school contexts and other comparable learning environments. The results of this trial suggest several interesting insights.

Key findings relate to two broad areas:

1. Teaching and learning implications: teacher planning and preparation, learning content, student learning, pedagogy and parents' concerns and needs; and
2. Technical and logistical considerations

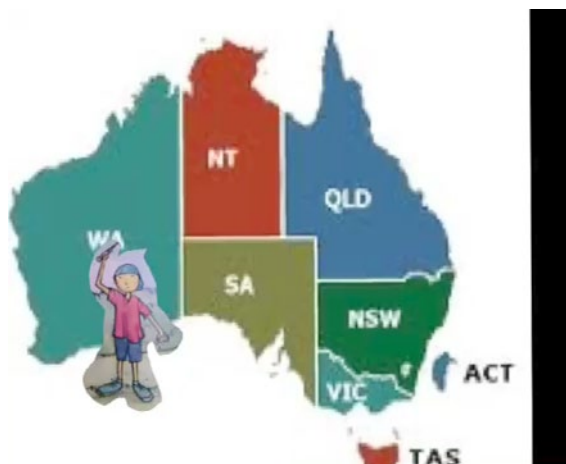
Teacher planning and preparation

It was acknowledged that the iPad placed additional demands on teachers' planning and preparation time. Significant time was dedicated to evaluating and procuring educational apps, determining relevance to the NSW curriculum and then installing these on individual student devices. The iPads were utilised in a

myriad of ways across most KLAS, but there was a tendency for the teachers to map the use of the iPad to the existing curriculum. This could be regarded as an antiquated approach in some instances.

Learning Content

Scrutiny of the apps utilised in the trial revealed that there was some alignment between the learning content prescribed by NSW syllabus documents and apps available in the iTunes App Store. Examination revealed that 43% were classified as instructive, games-based apps, despite teachers stating that they preferred content-creation, 'productivity' apps. The teachers suggested that the use of instructive games-based apps was suitable for aspects of the curriculum that demanded the rote memorisation of facts such as spelling and multiplication facts. The provision of instant feedback, an element of competition and the ability to prescribe different levels within games-based apps, appealed to both the students and teachers. However, teachers believed that optimal use of the iPads was attained when students used content-creation 'productivity' apps as this developed higher order thinking skills and provided creative and individualised opportunities for students to express their understanding. The content-creation apps also provided opportunities for increased collaboration amongst students. An example of a professional piece of work created by a student from Hovell Public School is showcased in Video 1. This video highlights how a Year 3 student used the iPad and an array of its peripheral technologies and software applications (voice recorder, camera, screen recorder) to create a digital work sample that accurately conveyed her understanding and recall of the text *Are we there yet?*



Video 1. A student work sample created using the Puppet Pals app, an example of a content-creation app

Student Learning

The pilot study found that many of the design features of the iPad offered learning affordances. Findings indicated that both teachers and students believed the iPads supported and enhanced student learning. These affordances were actualised because of the ways in which the teachers deployed the devices and embedded them in authentic and rich learning experiences, as highlighted in Video 2. In summary, this trial provided evidence to support claims that iPads enhance engagement and motivation, improve face-to-face and online collaboration amongst students, personalise learning and improve learning outcomes. Teachers ascribed these gains to many factors: the portability of the device; teachers' ability to easily differentiate instruction to cater for individual learning needs and preferences; the ease with which students could create

professional and aesthetic digital artefacts and appropriate apps to scaffold and compensate for students' emerging skills, for example, the predictive text function to support spelling skills; a strong sense of student ownership of learning; and the adoption of the metaphor that the iPad was a 'tool for learning'. The integration of a range of peripheral technologies within one device such as still and video camera, voice recorder, internet access, its intuitive design and simple interface and integration of apps, touch screen function and multimedia capabilities were also identified as distinguishing attributes of the iPad that facilitated learning.



Video 2. Students at Hovell Public School used i-nigma and GarageBand apps to engage in authentic learning experiences

The quick start-up, the mobility of the device and the integration of a range of peripheral technologies (still and video camera, Internet access and voice recorder) were sighted as the chief affordances of iPads which distinguished these devices from laptops or computers.

Pedagogy

As elucidated in Video 3, teachers involved in the trial reported that they adopted more student-centred and innovative approaches when using the iPad. There was evidence that teachers used the iPads to modify and redefine student learning, by employing transformative pedagogical models. They also identified that the synchronous use of a range of peripheral devices such as a video and still camera and voice recording facilities, afforded new opportunities for students to demonstrate their learning by using a range of multimedia. Using the iPad also resulted in an increase in students sharing digital work, via the interactive whiteboard (IWB) in many instances and this provided opportunities for the teacher to provide ongoing, just-in-time feedback and also collect cumulative assessment data. As an intuitive device, the iPad acted as a catalyst for more creative pursuits and exploration of new pedagogical approaches, as identified in Video 3.



Video 3. Teachers explain how they explored more innovative pedagogies when using the iPads

'The iPad is a consumer device: When you get frustrated with how the iPads work in a shared environment, remember that you are shoe horning a device that's designed for a single user into a shared classroom setup. There will be sharing issues, and until Apple addresses them, you will have to work around the issues' (Hasic, 2011, p. 8).

Technical and logistical considerations

This pilot study has provided some important caveats which are particularly relevant when considering the implementation of iPads within NSW DEC contexts, (as exemplified in Video 4.) iPads are primarily designed as a single-consumer device which has significant ramifications for school deployment. These include Internet connectivity with a proxy server, restricted Internet access and exporting student work created on a device. Management time associated with setting up the devices and establishing iTunes accounts were identified as potential barriers to future users.



The trial identified important school infrastructure considerations related to wireless devices, connecting iPads to interactive whiteboards (IWBs) and the purchase of peripheral devices such as protective covers and headphones. Findings also indicate that there are significant decisions to be made regarding the most time efficient methods of installing and updating apps in accordance with iTunes licensing regulations. The trial also illuminated the necessary components for future teacher professional learning regarding the use of mobile devices. As the iPad is an intuitive device, the emphasis needs to be on pedagogical approaches and task design, rather than on the technical aspects of using the device. Further technical and logistical information about deploying iPads in DEC schools can be found in the document 'Sydney Region Apple iPad 2 trial'.



Video 4. Steve, Principal at Hovell Public School, discusses the technical issues associated with deploying iPads at his school

It is important to note that given the transient nature of technology and the rapid pace of advancements, some of the findings in this report may no longer be current at the time of publication, as new operating systems often ameliorate technical and logistical issues. It is also critical to stress that whilst this report focuses on the iPad as a touch device, many of the findings could be equally transferable to other touch or tablet devices, particularly those related to curriculum, planning and preparation and student learning and pedagogy.

Key Recommendations

Key recommendations based on this evaluation are summarised below. These synthesise the recommendations and implications for teaching and learning and further research as detailed in the body of the full report.

School Administration

Schools must make careful decisions about deploying and sharing iPads across classrooms. As they are primarily designed as a single-consumer device and not supported centrally by DEC (at the time of publication of the evaluation), alternative technical and support models need to be considered prior to their implementation.

- Schools must budget for additional costs beyond the initial outlay for iPad devices to ensure they are effectively implemented in the classroom. Infrastructure costs and teacher professional learning are two essential components.
- Schools and administrators need to carefully consider how to store and share student content created on mobile devices.

Teaching and Learning

iPads needs to be considered as an educational tool that can support learning. They have the potential to afford new opportunities for learning if accompanied by student-centred pedagogies and authentic learning experiences. Given the preponderance of apps available in the iTunes App Store, teachers need to make critical and informed decisions when selecting apps.

- An app selection rubric that provides teachers with explicit criteria against which to judge the effectiveness of an app should be developed and disseminated to teachers.

- The development of a dynamic, online app database to provide NSW teachers with current information about educational apps and their relevance for learning could be established.
- A collaborative environment where teachers can comment on each app's educational viability and perhaps suggest how it has been used in a learning context may be helpful.

While this evaluation illuminated the effectiveness of instructive, games-based apps for promoting students' recall of facts, teachers are encouraged to source content-creation 'productivity' apps. Instructive, drill-and-practice game apps should be used sparingly to aid students' recall of facts requiring rote memorisation such as spelling patterns and rules, multiplication tables, addition and subtraction facts. Content-creation apps are characterised by their more open ended design and it is postulated that they foster higher levels of thinking and engagement, than apps with an instructive pedagogical design. Teachers should also consider using iTunes U and the newly released iBooks app to seek educational resources and digital materials rather than relying solely on apps from the iTunes App Store.

The deployment of mobile devices in the classroom demands the overt teaching of 21st century skills, as presently advocated by the National Curriculum.

- The explicit teaching of critical literacy and visual literacy skills is paramount given the periods of time students spend using digital media and their exposure to digital images.
- Students need to develop a comprehensive understanding of copyright regulations, particularly as they pertain to generating and publishing digital content.

Parents

Parents need evidence-based information about the safe and effective use of mobile devices, where to seek quality apps, and suggestions for ways these devices can be used at home to support learning. In particular, parents expressed a need for alternatives to 'game' apps, with a preference for their children to use learning apps. Parents are also looking for information about the impact of these devices on student learning and development.

Professional Learning

As they are an intuitive device, limited technical training is required to implement iPads, apart from explicit instructions on how to set-up the devices and iTunes accounts. However, professional learning should also encourage teachers to consider the pedagogical approaches that best optimise the iPad's use in the classroom. Professional learning opportunities also need to focus on directing teachers how to locate and appraise the educational value of apps.

- Creation of a systematic process for evaluating apps is recommended (as stated previously, the app selection rubric may assist in this process).
- Teacher education on copyright regulations within a digital environment is critical to enabling them to provide students with pertinent 21st century skills.
- Explicit training may be required by DEC curriculum advisors on the best ways to implement iPads in their area of expertise as there is great variation in how the iPads are implemented across the curriculum and the availability of apps for specific subject areas.

Research and Development

Further empirical research is required to quantify the benefits of mobile technologies on student learning outcomes. Longitudinal and empirical data is required to explore the broader educational impact of iPads on student learning. Further trials should be conducted with early years students and secondary students to determine if the findings from this study are replicated with a broader range of students. Given the release of Apple's latest educational offerings in January 2012—iTunes U app, iBooks and iBooks Author—further research is required to examine their effectiveness in a classroom. In particular, the alignment of these devices with student-centred approaches warrants further investigation.

There is a great dire need for apps that go beyond the drill-and-practice and games-based paradigms. Developers need to design apps that are vastly different to the design of 'skill-and-drill' software that currently dominates much of the educational market. Touch devices present unique opportunities for enhancing students' understandings of abstract concepts through the presentation of dynamic representations, opportunities for embodied learning and the inclusion of interactive elements.

- App developers need to consider the design and production of content-creation constructive apps, particularly for schooling contexts. Apps that provide tools for authoring, manipulation and communication are required.
- App developers need to consider piloting apps with students before finalising their design.
- App developers need to design apps which capitalise on the unique functionality and capabilities of an iPad such as the multi-touch gestures feature, sweep-action on-screen, gyroscope and accelerometer.

Glossary

Word	Definition
accelerometer	'With the built-in accelerometer, you can rotate iPad to portrait or landscape or even upside down, and whatever you're watching, reading or seeing adjusts to fit the display.' (Apple, 2011, source: http://www.apple.com/au/ipad/features/)
access point	iPads need to connect to a wireless access point (WAP) using WiFi. The WAP usually connects to a router using a wired network and relays data between iPads connected to the network.
airplay	AirPlay allows users the ability to wirelessly stream photos, videos and music from iPads to a television using Apple TV (2 nd generation).
apps	An 'app' is an 'application' which is a mini-program that can be downloaded onto an iPad from the iTunes App Store. Some apps are free, while others need to be purchased, costing from \$0.99 per app and upwards.
augmented reality	Elements from the real world and physical environment are augmented by sensory input from a device (such as sound or graphics).
blogs	The word 'blog' stands for a 'web log'. Blogs are typically described as an online journal published on the world wide web. They can contain digital work of an individual or a group of people and may include videos, digital work samples and photographs in addition to text. Depending on security settings some blogs allow readers to leave comments.
cloud computing	Cloud computing involves the delivery of computer services via a web browser or app, with data stored on servers in a remote location. Many Web 2.0 tools are examples of 'cloud computing'.
cloud storage	Cloud storage is an online data storage system accessed via the Internet and hosted by a third party. iCloud and DropBox are two popular examples of cloud storage.
constructive apps	<i>Constructive apps</i> are characterised by an open-ended design that allows users to create their own content or digital artefact using the app. Musical apps, presentation apps and drawing apps are emblematic of <i>constructive apps</i> . They are also referred to as 'productivity' apps.
embodied learning	Embodied learning is an approach to learning developed by cognitive scientists. It is based on the premise that knowledge and thinking processes are inextricably connected to physical interactions with the world (Clark, 1999; Wilson, 2002). Preliminary research indicates that physical interaction with a mobile device may assist students in developing more robust conceptual understandings.
gyroscope	A function of the iPad 2 that senses movement and rotation of the device. It works in tandem with the accelerometer to sense motion. It is useful for movement games and augmented reality.
instructive apps	<i>Instructive apps</i> have elements of 'drill-and-practice' design whereby the app delivers a predetermined 'task' which elicits a homogenous response from the user. These apps require minimal cognitive investment on behalf of the learner. Most game apps are classified as <i>instructive apps</i> .
iTunes U	iTunes U allows users to access courses from universities and other education institutions throughout the world. It provides free access to educational content. In January 2012, Apple released a free iTunes U app for the iPad.

Word	Definition
manipulable apps	<i>Manipulable apps</i> allow for guided discovery and experimentation within a pre-determined context or framework. These apps require more cognitive involvement than <i>instructive apps</i> but less than <i>constructive apps</i> .
multi-touch gestures	As a 'touch device' the iPad can respond to multiple touches simultaneously. The device transforms a user's taps, swipes, pinches, and flicks into lifelike actions.
peripheral technologies	The iPad has several additional technologies embedded in the device including a digital camera, video camera and voice recorder. No additional cables or software are required for these devices to operate.
podcast	A podcast is a digital media that consists of either audio or video files that are subscribed to and/or downloaded via web syndication (Internet or iTunes).
Posterous spaces	Posterous Spaces is a website that allows users the ability to share and upload their digital data such as photos and videos anywhere, anytime. The website can be accessed via https://posterous.com/ .
QR codes	'QR' is the acronym for 'quick response'. A QR code is similar to a barcode used by retailers. These codes can be read by a camera-enabled smartphone or device (such as an iPad) and link to multimedia content such as a website or text document.
smartphone	A smartphone is a mobile phone based on a computing platform that offers users computer functions and Internet access.
sweep action on-screen	The sweep-action is one of the multi-touch functions that can be used on an iPad.
synching station	A synching station describes the configuration whereby an iPad is connected to a computer or laptop via a USB. There are now commercial synching carts available for purchase, which allow multiple iPads to be stored, charged, synched and transported, similar to using a trolley system.
tablet technologies	'Tablet technologies' is a generic term to describe a variety of different mobile computers that either have a touch-screen or a stylus-enabled interface.
VGA adapter	Video graphics array (VGA) mirrors everything displayed on the iPad2 on a bigger screen: a VGA-equipped TV, monitor or external projector for video mirroring.
Web 2.0 tools	Web 2.0 technologies describe a group of web-based technologies that allow users to not only retrieve information from the Internet (Web 1.0) but also to create and share content and collaborate with other users. Blogs, wikis, podcasts, social media sites (Facebook, Twitter) and video sharing sites (YouTube) are examples of Web 2.0 tools.
wiki	A wiki is a website where users can add, modify and delete content using a web browser. Wikis are typically created collaboratively by multiple users.

Introduction

In 2010 when the iPad made its debut, there was little doubt that it would revolutionise mobile tablets for adult users. However, few imagined at the time, that it would spawn a multibillion-dollar market for mobile applications (apps) and fewer imagined that this would become a significant market for young students. Less than two years after the iPad's inception, there has been a swift adoption of these devices in schools and tertiary institutions across the world and a corresponding bombardment of apps classified as 'Education' in the iTunes App Store.

Apps are undoubtedly a source of fun and entertainment but more recently educators believe they have significant educational potential for providing content and may support students learning. Mainstream media and industry sources have provided anecdotal descriptions of how iPads are being used by students, schools and tertiary institutions. This rapid uptake has generated much interest and information about how these devices support the learning process but there is a paucity of research to substantiate claims that these devices and applications (apps) enhance learning.

While some preliminary trials have been conducted in various educational institutions, their findings have been disseminated in non-peer reviewed publications and often in the form of a terse summary statement posted on the institution's website. In most instances the research has been concentrated in secondary schools and tertiary institutions, with few trials being implemented in primary school settings. Another limitation of existing work in the field is the focus on the technical aspects associated with deploying iPads. Although this is undoubtedly an important consideration, and certainly a focus of this trial, other plausible considerations must be addressed, especially those regarding how teaching and learning are shaped by the devices.

This trial study sought to address some of the shortfalls in the existing corpus of research by focusing on the use of iPads exclusively within primary school settings. It endeavours to provide teachers and school administrators with evidence-based information about the optimal use of iPads, their impact on teaching and learning and to highlight any technical and logistical considerations that need to be addressed in a school setting where deploying iPads is being considered.

Literature Review

This section will present an overview of the pertinent literature related to children's use of technology, poor adoption of technology and the possibilities presented by mobile devices. It will start with a broader overview of educational technology and then explore more specific research as it relates to mobile devices (in particular iPads) and apps, in order to frame the current trial study. The structure of the Literature Review is summarised in Figure 1.

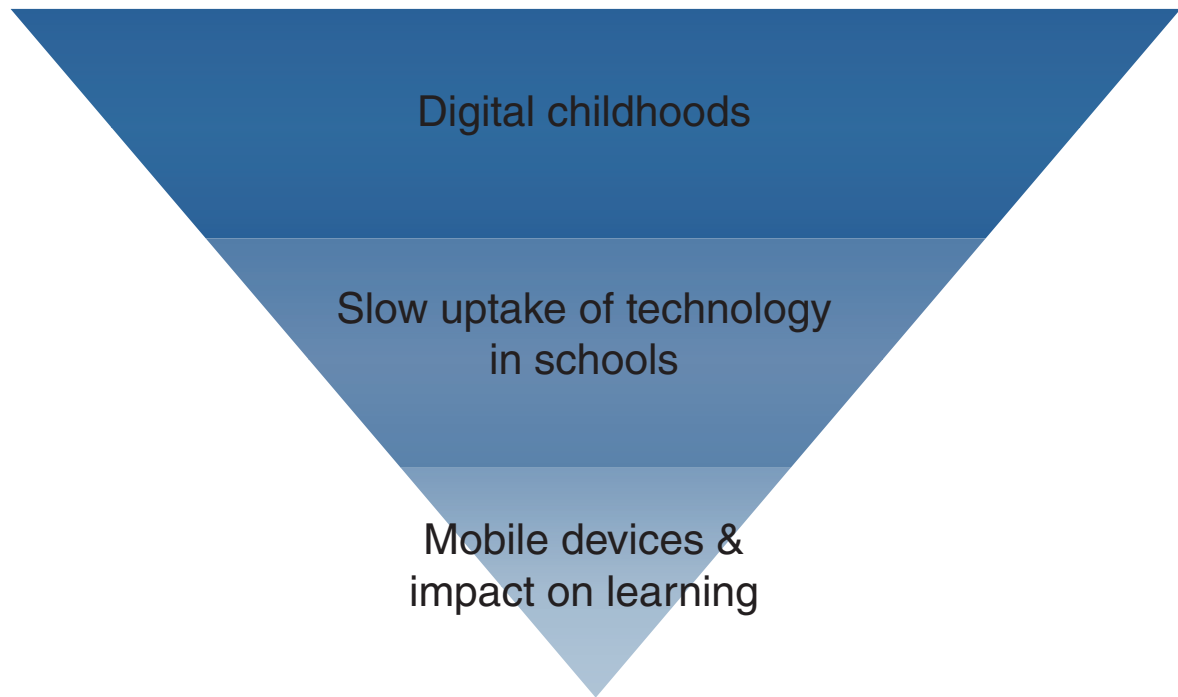


Figure 1. The structure of the Literature Review

Digital Childhoods

Young children grow up immersed in digital technologies as it is a ubiquitous component of our everyday activities. They live in a period of accelerating technological change. As software and hardware have simultaneously become cheaper, more sophisticated and easier to use, this generation is burning self-shot home movies, composing and recording music and editing photos' (Green & Hannon, 2006, p. 19). Immersed in a digitally rich culture, young students are imbued with sophisticated technical skills and learning preferences that are aligned with their digital habits (Prensky, 2001a; Yelland & Lloyd, 2001). Prensky (2001a) has coined the term 'digital natives' to describe children born between approximately 1980 and 1994 because of their familiarity with, and immersion in, digital technologies. This group are similar to today's young learners as digital technologies permeate their lives in the form of computers, videogames, digital music players, video cameras and mobile phones (Prensky, 2001b, p. 1). Young children are major consumers of technology and software as their leisure pursuits often include popular media, where media and entertainment converge. However, the use of the term 'digital natives', has recently been questioned. It has been suggested that it is not based on empirical research, but is a form of 'academic moral panic', which suggests a polarised view of technology culture and school life (Bennett, Maton, & Kervin, 2008, p. 782). Bennett and colleagues (2008) suggest that not all students are necessarily immersed in a technology rich culture. While it is important to acknowledge that not all students have access to technology at home and not all students' lives are permeated by technology, general patterns of

technology usage have increased and for many Australian students (as it has in many other developed nations), technology is a regular and important part of their lives outside of school.

Schools are charged with the responsibility of preparing students for life, but there is an increasing gap between what occurs in schools and students' out-of-school experiences. Often, there is a digital divide between school and home (Prensky, 2001a, b). Many students' home lives are saturated with digital technologies but the school environment is almost antithetical with minimal or tokenistic use of technology regularly transpiring. Students are required to acquire skills and knowledge often without the use of technologies that are considered ubiquitous in their regular daily lives.

Young students' orientations towards learning are now commensurate with learning with digital technologies, possibly as a result of their exposure to digital toys and games. 'Most children simply accept the ubiquitous place of technology as an unremarkable feature of life' (Green & Hannon, 2006, p. 44). Research has confirmed that children now enter kindergarten with predispositions for learning with digital technologies (Downes, 2003; Downes, Arthur, & Beecher, 2001; Teaching and Learning Scotland, 2003). Neuroscience has also investigated brain plasticity and has found that sensory input reorganises the brain (Prensky, 2001a). Prensky (2001a) proposes that today's learners process more information and more rapidly than previous generations, are adept at non-linear, parallel processing, have a preference for graphics (as opposed to text) and hanker after an active role when learning because sensory input from exposure to technology has reorganised their brains. Therefore, the proliferation of technology in young students' daily lives has shifted students' perceptions of their role as learners and has simultaneously altered their cognitive structures (Cuthell, 2004; McLoughlin & Krakowski, 2001). This change has ramifications for students' preferences and expectations of learning and may alter their preferred modes of learning (Downes, 2002; Prensky 2001b). Therefore, if school experiences are to be commensurate with students' home and leisure pursuits, then the use of technology should be incorporated into school learning experiences.

However, it is widely agreed that computers, so far, have made surprisingly little impact on schools: in fact, far less than in other realms of society such as media, medicine and law. The next section will provide an overview of the low use of technology and account for this poor uptake.

Slow Uptake of Technology in Schools

While it is difficult to ascertain the exact amount of time devoted to computer use in classrooms, emerging research is suggesting that students spend significantly less time using technology at school, compared to their home use (O'Riordan 1999, DfES 2001). A report released in January 2006 by the OECD PISA showed that 15% of Australian students reported 'frequent use' of educational technology at school, and 35% reported that they used technology 'a few times a week' (Organisation for Economic Co-Operation and Development, 2006). According to a recent government report, Partnerships in ICT (Information and Communications Technology) Learning, Australian schools are at the early stages of integrating computers into classrooms (Pegg, Reading, & Williams, 2007). This large-scale study was based on anecdotal evidence that the 'use of ICT in schools was neither widespread or significant' (Pegg et al., 2007, p. 100). Although many schools are purchasing technology infrastructure, the educational effectiveness is often compromised because teachers do not utilise it as much or as productively as they could. The report also suggests there are large disparities between computer use in schools, particularly between city

and rural schools, and that many teachers remain sceptical about computer use in the classroom, further hampering the adoption and integration of computers and new technologies. The report suggests that there is an 'avoidance culture' amongst educators to adopt and integrate new technologies (Pegg et al., 2007, p. 100). Research has consistently shown that technology use at school is not as challenging, nor as frequent when compared to home use (Fitzgerald, 2005). It appears that we need to bridge the gap between the learning that transpires outside of school and that which occurs in classrooms.

Despite increased access to technology, there are several, generic obstacles which inhibit the integration of technology (Vrasidas & Glass, 2005). These barriers are not restricted to early years classrooms but are evident in many educational settings. Such barriers relate to pedagogical reforms that often accompany the introduction of new technologies. Teachers are forced to question and modify their pedagogical repertoire to accommodate new technologies and leverage their affordances (Cox et al., 2003b; Yelland, 2007). Inadequate professional development has also been consistently identified in the literature as limiting the use of technology in schools (Bennett & Lockyer, 1999; Downes, Fluck et al., 2001; Dwyer, 2004; Vrasidas & Glass, 2005). Another limiting factor hindering technology integration relates to mapping new technologies to out dated curricular conceived in the pre-computer era (Kozma, 2003; Yelland, 2007).

There has been a long history of reluctance amongst some educators to adopt new technologies. Schools face an enormous challenge when trying to select technological devices that are current and educationally sound. The iPad has been swiftly adopted in many educational settings across the globe and very well received by both teachers and students. Hence it represents a rich potential as an educational device. iPads and other mobile devices have been touted as transformative devices. However, as sceptics suggest the history of educational technology is littered with many false promises and disappointing results. There is a need for rigorous, scientific research to confirm these assertions but to date there is no known research published in academically referred journals or publications.

The Curriculum as a Hindrance to Technology Adoption

Yelland (2007) proposes that we have mapped new technologies onto old curricula. Yelland (2007) suggests that serious thought needs to be given to how the curriculum can be reshaped to support new learning. There has been a tendency to 'digitise' existing content to suit the needs of the existing curriculum. The curriculum that today's students have inherited has remained largely unchanged for decades and therefore fails to account for any authentic use of technology (Yelland, 2007). There are calls for curriculum documents to be updated to be commensurate with the needs of the 21st century. However, didactic teacher-centred pedagogies still dominate many classrooms, with little 'incorporation of new pedagogies which utilise ICT to enrich learning and understandings in new and dynamic ways' (Yelland, Neal & Dakich, 2008, p. 2).

The Australian Council of Deans of Education (Australian Council of Deans of Education, 2001) proposed the concept of 'new learning' to re-shape learning in the 21st century. One of its eight propositions articulated that technology would be central to all learning. While it is generally accepted that technology should be an integral part of the learning process in schools today, technologies still remain peripheral to the main work conducted in many classrooms. Tokenistic use of technology divorced from students' digital culture often transpires in classrooms.

The Australian Curriculum, in its current form, emphasises inherent capabilities required for learning in the 21st century. The curriculum is devised around the development of a set of generic skills and capabilities: literacy, numeracy, ICT competence, creative and critical thinking, ethical behaviour, personal and social competence, and intercultural understanding (ACARA, 2011). These skills and capabilities are important to students living in a world where technology allows for learning to occur ‘anywhere, anytime’. This presents new challenges for delivering a curriculum with a specific technology focus. Mobile learning devices are considered as a viable means of ensuring that this ‘anywhere, anytime’ learning can transpire.

Puentedura (2006) developed a Substitution, Augmentation, Modification, Redefinition (SAMR) model that is summarised in Figure 2. It was designed to help educators identify different ways in which they can integrate technology into teaching and learning practices. It also provides teachers with a common language to describe the ways they integrate technology into their practice and enables teachers to identify the specifics of what they do and why. Puentedura’s model can be considered as a continuum from novice level (substitution) to an advanced, ideal level of technology integration (redefinition) to encourage teachers to seek optimal ways to include technology in learning experiences. Not surprisingly, many teachers are still using technology at a substitution and augmentation level because they are attempting to match technology to antiquated curriculum documents. However, the iPad offers teachers (and students) rich opportunities for transforming learning and using technology to modify and redefine learning. As a mobile device that is intuitive to use, teachers can easily provide engaging learning experiences for students using the iPad. This may enable teachers to use technology in a transformative fashion and simultaneously appeal to today’s students’ digital culture.

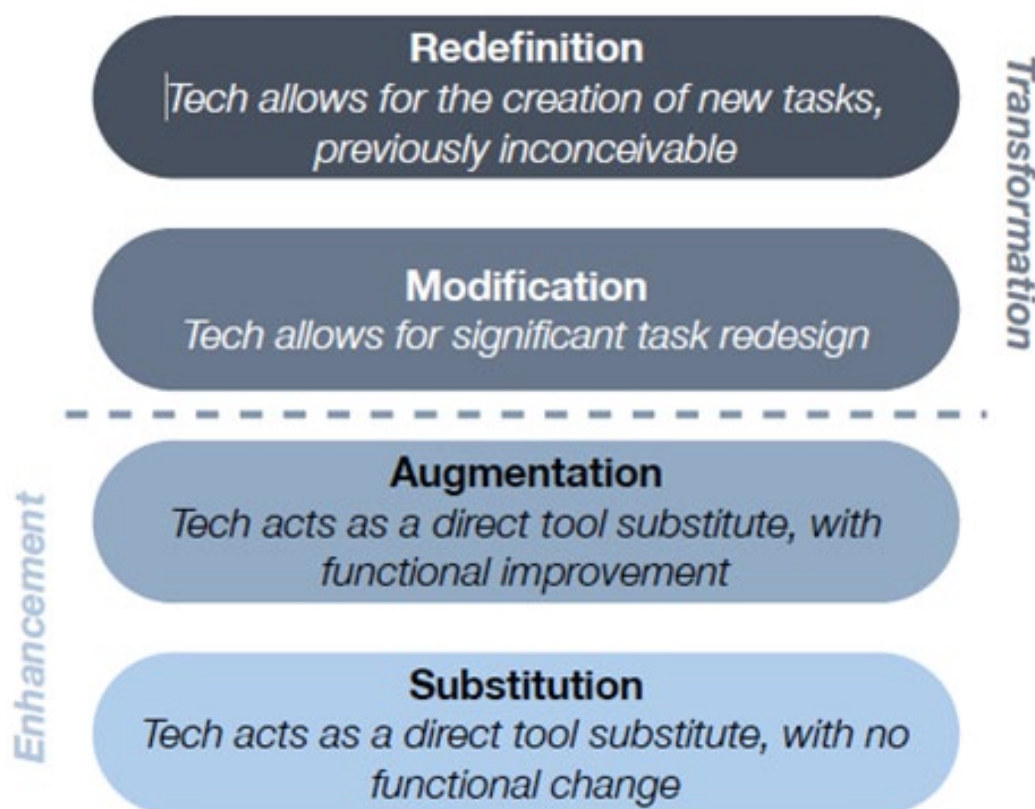


Figure 2. Puentedura's (2006, p.16) model of technology use

Mobile Learning

Mobile media are changing the lives of adults and children of all ages across many developed countries. Emerging feasibility and effectiveness research indicates that smart mobile devices have the potential to help advance students' learning (Chiong & Shuler, 2010). Mobile devices were identified by the Horizon Report (Johnson, Adams & Haywood, 2011) as an emerging technology likely to have a large impact on teaching and learning. Mobiles, especially smartphones and tablets, enable ubiquitous access to information, social networks, tools for learning and productivity, and hundreds of thousands of custom applications' (Johnson, Adams & Haywood, 2011p. 6). It has been proposed that mobile devices offer an affordable and advanced solution to foster collaboration, engagement and personalisation of the learning environment. However, there is a lack of research on the impact and effectiveness of such devices particularly in primary school classrooms.

A recent meta-analysis of research pertaining to mobile learning revealed that, '... access in school tends to more fully engage students, and portability extends their learning beyond the school. Experts suggest that these personal devices can increase motivation, organizational (sic) skills, independent and active learning, and self-directed learning (Fadel & Lemke, 2009, p. 32). Interestingly, this report by Fadel and Lemke (2009) also found that despite an initial positive response by educators and students alike, there is an absence of rigorous research that has examined their impact on learning.

Benefits of mobile learning

One of the chief affordances of mobile devices is that they enable learning anywhere, anytime, allowing learning to be shifted away from the industrial era model where the classroom is the central place of learning, driven by the teacher and limited to instruction within the school day. With mobile devices, the teacher is no longer at the centre of the learning process and the instructional time transcends the school day. Today, children are conditioned to expect that their technological experiences—accessing online communities, collaborating, creating content, sharing ideas and learning new things— are available 24 hours per day. Green and Hannon (2006) stress that our education systems need to emulate these models of learning and harness students' interest in technology. Deploying mobile devices is one way to engage today's learners and provide new capacities for learning. Mobile phones, tablets and other mobile devices provide users with access to a much more broad and flexible source of learning materials than offered by current classroom settings. Their portability extends learning beyond the confines of a classroom offering the ability to connect with other students, subject matter experts and mentors in a timely fashion.

They allow teachers to customise and personalise student learning experiences with appropriate content and resources that are congruent with their preferred learning styles. Green and Hannon's (2006) report on today's students revealed common characteristics in their use of technology in out-of-school contexts. These included self-motivation, student ownership, purposeful learning and peer-to-peer learning. It is hoped that mobile devices will address these characteristics.

Researchers have sighted the possibility of embodied learning, as a key affordance associated with mobile devices (Jewitt, 2005; Jewitt & Kress, 2003). This approach is grounded in the assumption that students' cognitive processes are connected to the body's interactions with the world (Clark, 1999; Wilson, 2002). Cognitive scientists now think that knowledge and thinking processes

are inextricably connected to physical interactions with the world (Clark, 1999; Wilson, 2002). It is postulated that physical interaction with a mobile device may assist students in developing more robust conceptual understandings. Mobile technologies allow developers to create more engaging learning experiences because they move beyond the static representations characteristic of traditional instruction. With touch-sensitive screens that can be 'pinched' to zoom in or out and sensors that detect when the device is being moved or tilted, mobile devices, such as the iPad can afford embodied learning experiences.

The research has identified three characteristics of mobile devices that distinguish them from portable devices such as laptops that can offer benefits to learners:

1. ubiquity—mobile devices can be accessed anywhere, anytime;
2. intimacy—the user sometimes forgets that they are using a mobile device, whereas a laptop maintains a physical presence because of its screen and
3. embeddedness—the device becomes part of the user's thinking as a tool to solve problems, interact with the world and perform common functions (Puentedura, 2011). The metaphors of 'a lively sketchbook' (Puentedura, 2011) and 'curiosity amplifier' (Brown, 2010) have also been associated with mobile devices and iPads in particular.

Issues with mobile devices

In order to harness the rich potential of mobile devices there are some generic issues that must first be considered including:

- the infrastructure required to operate mobile devices
- teacher professional learning required to facilitate the uptake of these technologies
- safety and privacy of student information
- re-examination of current curricula which are firmly rooted in the industrial era (Yelland, Cope & Kalantzis, 2008).

Each of these issues are considered in the current trial.

iPads as a learning tool

In recent years there has been a spike in consumer demand for touch technologies including touch-screen smartphones and tablet devices. Two hundred and forty four million touch devices were sold in 2009 and 630 million were sold two years later (Barseghian, 2011b). The introduction of the iPad in May 2010 has accounted for much of this demand. According to Barseghian (2011b) iPad sales nearly quadrupled in 2011 compared to 2010. According to Apple, 1.5 million iPads are already in use in educational institutions, with over 1000 schools having one-to-one iPad programs (Apple, 2012). Apple also noted the rich app ecosystem has been built around the iPad as a learning device with over 20,000 educational apps made specifically for the device (Apple, 2012). However, this rapid adoption of touch technologies has not been matched by research on the impact of touch technologies on students' learning. As the iPad was only introduced to Australia on May 28, 2010, no longitudinal studies have been conducted to confirm that they are a valuable learning tool. However, the swift adoption of the devices in educational institutions indicates that teachers are eager to explore their potential in supporting student learning.

Research suggests that it is imperative to view technology not as a tool in itself but rather as a 'cognitive tool' (Johnsen, Peck & Wilson, 1998; Weston, & Bain, 2010). It is yet to be proven that iPads are the panacea for poor technology uptake in school systems.

Initially, research on the educational effectiveness of iPads was restricted to small-scale, single-class studies conducted within colleges and universities (Anonymous, 2011). However, as iPads and other touch devices continue to rise in popularity and school systems are eager to ascertain their viability in classrooms there has been a recent surge in iPad trials implemented in Australian contexts.

A series of iPad trials have been conducted in nine Victorian primary and secondary schools and the Royal Children's Hospital Education Institute (see Department of Education and Early Childhood Development, 2011). With over 700 devices deployed, the purpose of this trial is to examine the impact of iPads on student learning and teaching practice. The Learning Exchange from the Catholic Education Diocese of Parramatta conducted a trial of iPads in 2010. Titled the 'iPads in Schools: Use Testing', this comprehensive report explores the iPad as a learning tool in eight primary and three secondary classrooms (Catholic Education, 2011). In the Northern Territory, the Department of Education also established an iPad trial in five secondary schools. The aim of this study was to examine how these 'emerging devices and technology (to) provide teachers and students with improved learning opportunities' (Northern Territory Government, 2011). At Redlands College, Queensland, iPads are being used with middle and secondary students via a one to one provision.

All of these trials have provided conclusive evidence to suggest that iPads have had a positive and significant impact on student learning. A consensus in their findings is that learners are more engaged and motivated; encouraged to demonstrate their understanding in a multitude of ways through the provision of tools not possible with traditional media; and higher order thinking skills such as critical thinking, problem-solving and decision-making skills are promoted.

In 2010 the State of Ohio Department of Education conducted a study on the effectiveness of iPads in supporting disenfranchised sophomore students' literacy learning. The findings from this study indicated 'that iPads played a statistically significant role in increased student achievement in the area of literacy' (Harmon, 2010, p. 6). Another study indicates that, 'the iPad promotes both efficient use of time and more learning moments' (Abilene Christian University, 2011). Both of these studies have provided empirical data to support the claim that learning is improved with iPads.

Affordances of iPads

'As a single device that is smaller than a laptop, the iPad combines robust computational functionality with a screen large enough to serve as a legitimate replacement for printed textbooks and other course materials, with the added benefits of interactivity' (Anonymous, 2011, p. 2).

The device's tactile interface and geographic information make this an appealing device for classrooms. The integration of a range of technological devices such as a camera and voice recorder means it can easily produce a range of multimedia artefacts. (It also has a longer battery life than a laptop.) Initial conceptions were that the iPad could be used as a media consumption device: as an e-reader with interactive features it was thought to 'substantively change the textbook experience' (Anonymous, 2011, p. 1). Interestingly, scrutiny of educational technology blogs and online forums suggest that preliminary

ideas about the iPad focused on it as a textbook replacement in schools. It is claimed that Apple's founder, the late Steve Jobs, saw the textbook market as ripe for digital disruption. This conception as a textbook replacement has perhaps driven the direction of app developers who have designed many apps that are congruent with a behaviourist design closely aligned with the design of many textbooks (Barseghian, 2011c). On 19 January 2012 Apple announced some major innovations for the education sector—that it will introduce iBooks 2 (multimedia textbooks), iBooks Author (for teachers and students to create their own multimedia textbooks) and the release of an iTunesU app (free access to educational materials) (Apple, 2012).

The 'Pass-Back' Effect

In two recent American studies conducted by the Joan Ganz Cooney Center at Sesame Workshop (Chiong & Shuler, 2010; Takeuchi, 2011), a new phenomenon among parents was identified called 'the pass-back effect'. This involves a parent passing over their mobile device to a child, at home, while travelling or running errands or dining outside the home. While there is no current Australian data to confirm this trend, anecdotal evidence on social observations suggests it is being emulated by many Australian parents. Parents are believed to hand over their device for two reasons—to induce passivity in the child whilst queuing or traveling in a car and to promote learning as many parents believe that touch devices are an educational tool and they are therefore searching for 'educational' apps to install. The parental assumption that mobile apps are a source of learning is interesting as there is limited research to confirm this belief. Both of these studies have illuminated how young children are using mobile devices in out-of-school contexts. It is therefore important to consider any ramifications of this trend on their preferences for learning at school.

Educational Apps

An 'app' is an 'application', a mini-program that can be downloaded onto an iPad from the iTunes App Store. Some apps are free but others must be purchased from \$0.99 per app.

Since the introduction of the iPad in Australia there has been an exponential growth in the number of educational Apps available for mobile devices, including but not limited to the iPad. There are over 500 000 apps available in iTunes and over 300 000 on Android. It is anticipated that apps will generate \$38 billion by 2015 (Shuler, 2012). However, developers haven't been able to back their claims of educational value for students: hence the urgent need for research to examine the educational effectiveness of apps.

A cursory search of the iTunes store will show the difficulty of locating quality educational apps despite a designated education category. Many apps are classified as 'educational' and located in the 'Apps for Kids' or 'Education' sections of the iTunes store giving the false impression that they offer educational content or are educational tools. Despite these categorisations these apps have not been subject to any scientific scrutiny or rigorous academic review process. Apple approves all apps in the iTunes store and provides customer reviews but these are not necessarily validated customers, they are and may be fictitious, which questions the reliability of such reviews.

A content analysis of the iTunes Store conducted by Shuler (2009) found that 47% of the top 100 selling apps (for iPhone and iPod touch devices) were designed for preschool or elementary aged children with foreign language and literacy the most popular categories of apps (Shuler, 2009). Watlington (2011)

conducted a similar study in 2010, classifying the types of free Apps available for the iPod touch and iPad via the iTunes App Store. This study used the Haughland Developmental Software Scale (1998) to rate the developmental appropriateness of free iPad apps. It found that only 48% of the 108 Apps that were analysed were classified as developmentally appropriate and recommended for educational use. This study also found that foreign languages and the Language Arts areas were also the most popular apps for iPod touches. The findings from Watlington's (2011) study highlights the need of a systematic review of apps marketed towards young children and classified as 'educational'. Given that anecdotal reports suggest that teachers and parents most frequently look for apps for young children in the 'Education' section, a systematic analysis of the content and pedagogical design is warranted.

More recent research from the Joan Ganz Cooney Center at Sesame Workshop in the United States reveals that 80% of the top-selling paid apps in the 'Education' category of the iTunes App Store target children and 72% of these target preschool or elementary (primary) school students (Shuler, 2012). This content analysis also revealed that 20% of the overall sample of top-selling paid apps targeted elementary students, but almost 50% of the top-sellers targeted this age group (Shuler, 2012). This suggests that there is an abundance of apps for this age range.

Research on Apps

Research has failed to keep pace with the emergence of apps despite an 'app culture' emerging since the inception of the iPhone in 2007 (Purcell, Entner & Henderson, 2010; The NPD Group, 2010). There is little empirical evidence to confirm that educational apps are valuable for learning, despite the preponderance of apps marketed as 'educational'. One of the few studies that have empirically examined the impact of mobile applications on children's learning was conducted by Rockman et al (REA) (2010) and examined the effectiveness of two literacy apps designed by PBS Kids for young children. This study provided empirical evidence that young children can learn from apps and also identified some of the key characteristics that are inherent in successful app design for young children (such as developmental appropriateness, humorous activities, short wait times, incentives and parental involvement).

Houghton Mifflin Harcourt released an iPad app for Algebra (designed for Year 8 students) and conducted a comparative study with 1 000 California students to examine how those using the app perform compared to their counterparts without the app. While this study will be formally released some time in 2012, early indications are pointing to favourable results according to Barseghian (2011a).

A smaller scale study has also been conducted by Riconscente on behalf of GameDesk (2011) to examine the impact of the Motion Maths app on students' fractions knowledge and attitude. This fractions estimation iPad app was developed by graduates of Stanford University's Learning, Design and Technology program. The experimental study was commissioned by the game's designer but conducted by an independent researcher (Riconscente, 2011). Results showed that students' performance on fraction tests scores improved an average of 15% after using the Motion Maths app for 20 minutes per day over a five day period: a significant increase compared to the control group. Also, students' self-efficacy for fractions improved by 10% and nearly all students rated the game as 'fun' and acknowledged that the app 'helped them learn' (Riconscente, 2011).




While some preliminary research has been conducted to determine the effectiveness of mobile apps (PBS Kids, 2010, Shuler, 2009), much of the research of predominantly usability studies has been conducted by large media organisations of (Rockman et al, 2010). As an emerging technology, it is not surprising that there are no known empirical studies to substantiate the educational efficacy of apps specifically for young children.

Classification of Apps

Efforts have been made to classify the types of educational apps presently available in the iTunes App Store (Highfield & Goodwin, 2012; Michael Cohen Group LLC, 2011; Shuler, 2009a). The Michael Cohen Group proposed three types of educational apps: (i) creating apps, (ii) gaming apps (iii) ebook apps.

Highfield & Goodwin (2012) reported a content analysis conducted on 240 of the top paid apps that featured in the Education section of the iTunes Store over a six month period. Each app was viewed and classified according to its pedagogical design features based on a classification scheme originally devised to analyse interactive multimedia (Goodwin, 2009). Three broad classifications were proposed, based on the learner's locus of control over the activities presented in the app and their level of cognitive investment. The three broad classifications were instructive, manipulable and constructive. Two other sub-categories also emerged from the preliminary analysis: constructive/manipulable and manipulable/instructive Apps. These apps contained a hybrid pedagogical design with elements from both classifications. This classification scheme is summarised in Table 1 and was used to classify the types of apps used in the current trial.

Table 1. A classification of apps

Pedagogical Design	Example and App Icon	Summary
<i>Instructive Apps</i>	Math Bingo by ABCya.com is an example of <i>instructive</i> design. 	<i>Instructive</i> apps had elements of drill-and-practice design, whereby the App delivered a predetermined 'task' which elicited a homogenous response from the user. These apps required minimal cognitive investment by the learner.
<i>Manipulable Apps</i>	Toontastic by Launchpad Toys is an example of a <i>manipulable</i> design. 	<i>Manipulable</i> apps allow for guided discovery and experimentation, but within a pre-determined context or framework. These apps required more cognitive involvement than <i>Instructive</i> apps, but less than <i>Constructive</i> apps.
<i>Constructive Apps</i>	Drawing Pad by Darren Murtha is an example of <i>constructive</i> design. 	<i>Constructive</i> apps were characterised by a more open-ended design that allowed users to create their own content or digital artefact using the app. Musical apps and drawing Apps are emblematic of <i>constructive</i> apps.

This content analysis revealed some interesting findings (Highfield & Goodwin, 2012). Seventy-five per cent of apps available in the App Store were classified as *instructive*. This suggests that app developers have imposed behaviourist principles on the design of apps: a linear, prescriptive model of instruction is used. Predetermined responses are programmed accordingly and users select the correct answer. These apps are designed on the premise of information consumption and typically restrict creative thinking.

Puentedura's (2011) SAMR model has also been applied to classify apps, as shown in Figure 3. Ideally, for more transformative models of learning to occur, teachers need to encourage students to use apps that allow for 'modification' and 'redefinition'. In the example shown in

Figure 3, the app Proloquo2Go is used as an example of a 'substitution' app. In this instance the app is a direct tool substitute for a traditional task, without any functional change occurring. The same app is also suggested at the 'augmentation' level, suggesting that it is not so much the app that make the difference, but more the task that the teacher uses with the app. When the camera is used with the Proloquo2Go app, there has been a functional improvement. The Pictello app (a digital storytelling app) is used at the 'modification' level to indicate that the app allows the task to be significantly re-designed. The ideal use of apps is at the level of 'redefinition' as the iMovie app allows users to create new tasks, previously inconceivable without an iPad.

A SAMR Ladder for AAC



Figure 3. Puentedura's SAMR Model applied to the classification of apps (2011, p. 18)

Trial Information

A trial of tablet technologies, specifically involving the iPad, was undertaken in the Sydney Region in Terms 3 and 4, 2011, using 75 Apple iPads. The trial was implemented for a total of 18 weeks. Excluding the time required for initial training and disruptions at the end of the year, the iPads were used for approximately 14 weeks of teaching time. This is a relatively short trial period which needs to be considered when reading the results: a longer period of implementation may have yielded different results. Three schools were involved and details of their distribution are summarised below in Table 2. Pseudonyms are used to preserve the anonymity of the schools involved. The Regional Director purposefully selected the three schools.

Table 2. Summary of Participating Schools

School Pseudonym	Number of iPads	Distribution of iPads
Hovell Public School	31	One-to-one in a Year 3 class ICT Co-ordinator also used the iPads for ESL and Reading Recovery Lessons
Eyre Public School	31	One-to-two in a Year 3 and Year 6 class
Hume Public School	13	One-to-one in a composite Year 4, 5, 6 class

The iPads were distributed to the students on a daily basis but stayed at school (no home use). The devices could be customised and/or personalised by the students. In addition to the iPads, each school was provided with headsets, colour-coded protective covers, a VGA adapter to connect the device to a projector and a wireless access point that allowed wi-fi connectivity within a classroom. In addition, a \$50 iTunes card was distributed with each iPad to enable apps to be purchased for each device. It is important to note that at the time the trial was being undertaken, there was no volume purchase program for the App Store in Australia. Due to the copyright restrictions within an Education Licence, apps had to be purchased for each device. This required individual iTunes accounts for all devices (see the section 'Technical and Logistical Considerations' for further technical details).

The initial set-up of the devices and technical support was provided by the regional Technology Advisors (Stu Hasic, Greg Sharkey) and the Technology for Learning Administrator (Robert Pucillo). Steve King from the Education Unit at Apple Australia also provided some technical assistance in terms of the iPads operating within the DEC environment. Lena Arena was the project co-ordinator and Ariane Skapetis was the ICT consultant for Sydney Region. Stephen Sergis and Diane Read were the CLIC staff members representing the Next Practice Unit.

The participating teachers were provided with two full days of training that included one day at the Sydney Region Office and one day at the Apple Centre in Sydney in what is colloquially called the 'Sandpit'. The training day at the Regional Office provided teachers with an overview of the structure and expectations of the trial, information on management and licensing issues, iPad familiarisation, use of iTunes accounts, set-up procedures, a list of suggested educational apps and some useful web resources and links. Kate Fredrickson from the ICT Innovations Centre at Macquarie University also provided some professional learning opportunities where she focused on using QR codes (Quick Response) with iPads. The Apple Centre Sandpit day at the Sydney Apple Store provided teachers with opportunities to investigate iPad apps that were relevant to the NSW curriculum.

Research Questions

The NSW Curriculum and Learning Innovation Centre staff members in collaboration with selected staff members from the Sydney Region and the external evaluator devised the following research questions after the external evaluator was appointed. These questions informed the subsequent design of the teacher and student surveys and interviews and acted as a framework for analysing the data sources. The final evaluation had multiple focus areas: (i) to ascertain the impact of the iPads on teaching and learning from both teachers' and students' perspectives; (ii) to classify and identify the types of apps that support students' learning; (iii) to delineate the technical and logistical considerations that need to be addressed when implementing iPads into a school setting; and (iv) to identify pertinent information parents need regarding safe and effective use of mobile touch devices. These focus areas were consolidated into two broad areas: (a) Teaching and Learning; and (b) Technical and Logistical Considerations. The research questions are detailed in Table 3.

Table 3. Research Questions

Teaching & Learning Evaluation Areas
Learning Content
Is the content of apps relevant, accurate, current and engaging?
How well do the apps utilised align to the NSW BOS syllabus content?
To what extent were the iPads used for content-creation or content-receiving?
Teacher Planning and Programming
What preparation or support is required by the teacher to use iPads successfully in the classroom?
How did teachers go about sourcing apps?
How did the teacher integrate the use of the iPads in their teaching and learning program?
Student Learning
How did the use of the iPads balance between motivation and critical content learning?
How did the use of the iPads improve student knowledge and skills?
How did the use of the iPads support collaboration between students?
How was the learning personalised for the students? (control of own learning)
Were gender differences observed? Did boys and girls use the iPad in different ways? Did they respond in different ways?
How did the iPads impact on personalised learning?
How did the iPads support individual student's learning needs? (differentiation)
Pedagogy
How were the iPads used in the classroom? (classroom management)
How did the use of the iPads affect teaching practice? (i.e. more student-centred pedagogies or support teacher-directed approaches?)
How has the iPad afforded new opportunities for student learning?
How did iPads support assessment/reporting practices?

Technical and Logistical Evaluation Areas	
Technical Considerations	
How were the iPads initially set up? (iTunes and email accounts, synch stations)	
How was teacher professional learning facilitated? What other ongoing professional learning opportunities are needed? (e.g. access to a blog, regular workshops)	
What are some of the school ICT infrastructure considerations? (e.g. wireless access and signal distribution, incoming bandwidth?)	
How was student usage monitored?	
How were apps installed on each device?	
How did students save, publish and share digital content created on an iPad? (e.g. Drop Box accounts)	
Were the iPads used with Interactive Whiteboards (IWBs)? Were there any technical issues in doing so? What other infrastructure was required (e.g VGA adapter)	
Were the devices subject to existing web filtering when browsing or was a web filter added to the network?	
How were the iPads synchronised and updated? (e.g. iOS updates). Was this the same for a one-to-one implementation, as it was for one-to-many basis?	
How were Internet settings managed? (i.e. apps that required Internet connectivity)	
Were students able to select and install their own apps? How was this facilitated and managed?	
Logistical Considerations	
In one-to-one contexts, how did the students personalise and/or customise the device?	
How did students identify their device?	
How and where were the devices stored and charged?	
How often did the devices need to be charged?	
What procedures were in place to distribute and collect iPads? (i.e. were devices tagged or numbered?)	

Data Collection and Analysis

Table 4 below relates each of the research questions to a data source/s and synthesises the methods of analysis as they relate to the areas of Teaching and Learning of the evaluation.

Table 4. A Summary of the research questions, data sources and methods of analysis

Teaching & Learning Evaluation Areas	Data Source and Collection	Data Analysis
Learning Content		
Is the content of Apps relevant, accurate, current and engaging?	Teacher Interviews Teacher surveys (via Survey Monkey)	Coding and tagging of critical incidents from video footage from interviews Analysis of teacher survey responses (themes)
How well do the Apps utilised align to the NSW BOS syllabus content?	Database of Apps used in the trial, linked to syllabus outcomes Teacher interviews	Analysis of Apps matrix Teacher interviews
To what extent were the iPads used for content-creation or content receiving?	Classification scheme to be completed by teachers (using the abovementioned database) Teacher Interviews Teacher surveys (via Survey Monkey)	Coding and tagging of critical incidents from video footage from interviews Coding and tagging of critical incidents from video footage from site visits
Teacher Planning and Programming		
What preparation or support is required by the teacher to use iPads successfully in the classroom?	Teacher Interviews Teacher Surveys	Coding and tagging of critical incidents from video footage from interviews Analysis of survey responses (themes)
How did teachers go about sourcing Apps?	Teacher Interviews Teacher surveys (via Survey Monkey)	Coding of video footage from interviews Analysis of survey responses (themes)
How did the teacher integrate the use of the iPads in their teaching and learning program?	Teacher Interviews Teacher surveys (via Survey Monkey)	Coding of video footage from interviews Analysis of survey responses (themes)
Student Learning		
How did the use of the iPads balance between motivation and critical content learning?	Teacher Interviews Teacher surveys (via Survey Monkey) Observations during site visits	Coding and tagging of critical incidents from video footage from interviews and site visits Analysis of survey responses (themes)

How does the use of the iPads improve student knowledge and skills?	Teacher Interviews Teacher surveys (via Survey Monkey) Observations during site visits Student interviews Student surveys (via survey monkey) Student digital work samples	Coding and tagging of critical incidents from video footage from interviews and site visits Analysis of survey responses (themes) Analysis of students' digital work samples
How did the use of the iPads support collaboration between students?	Teacher Interviews Teacher surveys (via Survey Monkey) Observations during site visits Student interviews	Coding and tagging of critical incidents from video footage from interviews and site visits Analysis of survey responses (themes)
How was the learning personalised for the students? (control of own learning)	Teacher Interviews Teacher surveys (via Survey Monkey) Observations during site visits Student interviews	Coding and tagging of critical incidents from video footage from interviews and site visits Analysis of survey responses (themes)
Were gender differences observed? Did boys and girls use the iPad in different ways? Did they respond in different ways?	Teacher Interviews Observations during site visits	Coding and tagging of critical incidents from video footage from interviews and site visits
How did the iPads impact on personalised learning?	Teacher Interviews Teacher surveys (via Survey Monkey) Observations during site visits	Coding and tagging of critical incidents from video footage from interviews and site visits Analysis of survey responses (themes)
How did the iPads support individual student's learning needs? (differentiation)	Teacher Interviews Teacher surveys (via Survey Monkey) Observations during site visits Student digital work samples	Coding and tagging of critical incidents from video footage from interviews and site visits Analysis of survey responses (themes) Analysis of work samples
Pedagogy		
How were the iPads used in the classroom? (classroom management)	Teacher Interviews Teacher surveys (via Survey Monkey) Observation data from site visits	Coding and tagging of critical incidents from video footage from interviews and site visits Analysis of survey responses (themes)

How did the use of the iPads affect teaching practice? (i.e. more student-centred pedagogies or support teacher-directed approaches?) How has the iPad afforded new opportunities for student learning?	Teacher Interviews Teacher surveys (via Survey Monkey)	Coding and tagging of critical incidents from video footage from teacher interviews Analysis of survey responses (themes)
How did iPads support assessment/reporting practices?	Teacher Interviews Teacher surveys (via Survey Monkey)	Coding and tagging of critical incidents from video footage from interviews Analysis of teacher survey responses (themes)

In table 5 the technical and logistical areas of the evaluation are identified and a list of potential output sources are suggested. The team of Technology Advisors from Sydney Region primarily conducted this part of the evaluation. Hence, limited formal data sources and methods of analysis are detailed here as this part of the trial was based on the team's observations and practical experiences. Some rich data from the teacher surveys and interviews was also used for this part of the report.

Table 5. The Technical and Logistical Areas of the Evaluation

Technical and Logistical Evaluation Areas	Evaluation Output
Technical Considerations	
How were the iPads initially set up? (iTunes and email accounts, synch stations)	Guidelines for setting up iPads in school settings (for both one-to-one and one-to-many deployment configurations)
How was teacher professional learning facilitated? What other ongoing professional learning opportunities are needed? (e.g. access to a blog, regular workshops)	Suggestions for initial teacher training required to use iPads effectively in the classroom
What are some of the school ICT infrastructure considerations? (e.g. wireless access and signal distribution, incoming bandwidth?)	A checklist of ICT infrastructure required for iPad deployment
How was student usage monitored?	Suggestions for monitoring student usage
How were Apps installed on each device?	Instructions for installing Apps on iPads (in line with copyright regulations)
How did students save, publish and share digital content created on an iPad? (e.g. Drop Box accounts?)	Suggestions for saving and sharing student work
Were the iPads used with Interactive Whiteboards (IWBs)? Were there any technical issues in doing so? What other infrastructure was required (e.g VGA adapter)	Suggestions for using iPads with IWBs
Were the devices subject to existing web filtering when browsing or was a web filter added to the network?	Instructions for managing internet settings in DEC schools

How were the iPads synchronised and updated? (e.g. iOS updates). Was this the same for a one to one implementation, as it was for one to manybasis?	Guidelines for synchronising and updating iPads
How were Internet settings managed? (i.e. Apps that required Internet connectivity)	Instructions for managing internet settings in DEC schools
Were students able to select and install their own Apps? How was this facilitated and managed?	Suggestions for management of iPad devices in terms of App selection
Logistical Considerations	
In one-to-one contexts, how did the students personalise the device?	Suggestions for identifying, storing and charging iPads in a classroom context
How did students identify their device?	
How and where were the devices stored and charged?	
How often did the devices need to be charged?	
What procedures were in place to distribute and collect iPads? (i.e. were devices tagged or numbered?)	

Research Methodology and Design

This section outlines the methods used, the data collected and data analysis techniques, as summarised in Table 4.

Methodology

This Evaluation used a mixed methods research design. A descriptive, collective case study approach was employed. Each of the participating schools (n=3 primary schools) acted as 'sub-cases' (students and teachers). This involved two stages of data analysis: (i) within-case analysis and (ii) across-case analysis. This enabled the researcher to identify as many contextual variables that may have impacted on the cases. The cross-case analysis allowed for the development of abstractions across the sub-cases to identify the educational potential of iPads and their impact on teacher planning and programming, learning content, student learning and pedagogy. A case study methodology allowed the evaluator to describe how the devices were used throughout the trial period and account for any discrepancies between sub-cases. Triangulation of data occurred through the collection of multiple sources of data (described in more detail in the following section).

Student surveys

Online surveys were administered to students within the final two weeks of the trial (Term 4, 2011). Students completed the surveys individually on either desktop computers or iPads and in most instances the students completed the survey independently. Support was provided to those students requiring assistance reading the questions and/or typing a response. Survey Monkey, an online survey tool, was used to administer the survey and also for analytic purposes (see www.surveymonkey.com for details about this tool). The student survey was comprised of ten questions. A combination of multiple choice and open-ended questions were posed. Eighty-five students completed the survey from a total of four classes involved in the trial. The purpose of the survey was to determine students' thoughts on using iPads and preferences for the types of apps they liked using on the iPad. Preliminary results from the online surveys were used as a stimulus during the one-on-one student interviews, allowing the evaluator to delve more deeply into pertinent issues raised in the survey.

Student responses were aggregated using Survey Monkey analytic tools and also via repeated readings of student responses to enable the evaluator to identify global themes. The evaluator used the text analytic function within Survey Monkey to code the open-ended responses, providing some quantitative data for these questions. Using the text analytic function, the evaluator was able to categorise, code and filter students' important words. The text analysis feature automatically searched for important words and phrases within the students' comments and presented these either in 'Cloud View' or 'List View'. The Cloud View then summarised these key words by presenting them in different font sizes. The larger the font size, the more often that word was used by the students. The List View ordered the words shown in the Cloud View by highest to lowest number count, revealing the number of times (and percentage) that it appears within the comments. The evaluator also developed their own categories to tag responses together based on the content of the open-ended responses. This allowed the evaluator to view responses that pertained only to a specific category, create a filter and apply it to the comments. Then, a count of comments that had been tagged with a specific category, and their percentage of all responses, could be displayed.

Teacher surveys

Data about the use and effectiveness of iPads for teaching and learning was obtained via a detailed online survey administered at the end of the trial period. The surveys were completed online using Survey Monkey and consisted of both closed response and open ended items. A total of 30 questions were presented and a response rate of 100% (n=5) was achieved for the survey.

Data from the teacher surveys was analysed using the same techniques described in the section 'Student Surveys' above. Both qualitative and quantitative data were obtained from the online survey. The quantitative data from the surveys was aggregated and tables and graphs prepared. Given the small sample size (n=5), inferences obtained from the survey data may not be transferable to a larger population. The open-ended response data from the survey was coded according to recurrent themes and recorded in a theme matrix and some quantitative data was used to illuminate pertinent themes. The purpose of the survey was to provide some baseline data that could be explored more fully in a one-on-one teacher interview.

Parent surveys

All parents and/or guardians of students who participated in the trial were invited to complete an online parent survey. This survey was also administered via Survey Monkey. Parents were issued with letters inviting them to participate in the anonymous online survey and several teachers also emailed parents to remind them that they were encouraged to partake in the survey. At Hovell Public School a parent afternoon was hosted by the school to showcase the students' iPad work and during this event a Sydney Region representative attended and encouraged parents to complete the surveys using school laptops. In addition to the online surveys, parents were invited to be interviewed and one parent completed an interview. However, only 11 parents undertook the online survey. Literacy barriers and/or computer access may have caused the low response rate, or it may have been attributed to the demands placed on parents by the large number of notes at the end of the school year. The purpose of the parent surveys was manifold: (i) to identify the usability levels of mobile devices at home (including tablet devices and smartphones); (ii) to determine the types of apps and activities students undertook on such devices at home; (iii) to ascertain what parents want to know in regards to using mobile devices. The parent surveys were coded in the same fashion as the student surveys, described above. However, owing to the small sample size, limited quantitative data was yielded from the surveys.

Observation and field notes

Three site visits were conducted and the external evaluator kept observation notes. Another NSW CLIC member validated these observation notes for validity purposes. Observation notes were coded for themes and tentative themes were recorded in the theme matrix.

Lesson observations

Three site visits were conducted with each of the schools that participated in the trial. During the site visits, lessons involving the iPads were observed. Three of the four classes involved in the trial were observed due to illness of one of the participating teachers. Each lesson observed was video recorded by a CLIC staff member and also by the evaluator. In addition, the evaluator maintained written and verbal observation notes. The purpose of the lesson observations was to provide evidence of teaching practice with iPads and document students' engagement when using the devices. Only those students who had parental

permission to be filmed were included in the videos which limited the scope of the data presented in this evaluation. Repeated viewings of the video data allowed the evaluator to identify recurring themes. Again, critical incidents were tagged and subsequently recorded in the theme matrix.

Student interviews

Student interviews were conducted by the external evaluator during the site visits and recorded by a CLIC member. Parental permission was requested to interview selected students at the three schools during the site visits. A representative sample was sought: three female and three male students, varying in their overall academic ability. However, at two schools limited parental permission determined which students were able to participate in the interviews. The purpose of the interviews was to provide information on students' experiences with the iPads and to gauge their preferences and thoughts on using the iPad as a learning tool. This also allowed the evaluator the opportunity to probe any themes or issues that arose from the online student interviews. A secondary purpose of the student interviews was to confirm the teacher's observations and speculations about students' use and preference for particular apps. Student interviews were recorded with a digital camera and followed a semi-structured script. A conversational tone was established to allow students to provide candid responses. During the interviews, students were encouraged to use the iPad to showcase their work and explain why they liked (or disliked) particular apps. Repeated viewings of the student interview video data identified themes that were listed in the theme matrix. Critical incidents from the interview data were tagged and included in the theme matrix. Some of the student interviews appear in the evaluation in the form of videos.

Teacher and principal interviews

All participating teachers (n=5) and principals (n=3) undertook an in-depth semi-structured interview with the external evaluator at the end of the trial period (due to staff absence during one of the visits a CLIC staff member conducted one of the interviews at a later date). Interviewee's responses were not transcribed, but the video footage was viewed and tagged for critical incidents. Emerging themes from the interview data were recorded in the theme matrix and linked to the tags of critical incidents.

Student Work Samples

Each of the participating schools provided student work samples to exemplify the types of work the students had produced on the iPads. Copies of these were provided to the external evaluator as digital files on a USB or were emailed by the students. Where students' work had been uploaded to a class wiki (using Wikispaces or Posterous), the evaluator was granted access. Some of these work samples are included in this Evaluation to showcase the quality of work produced by the students using the iPad.

Blogs

The evaluator also reviewed two blogs: a teacher blog and class blog, both created using BlogEd. The five teachers involved in the trial used the blog to record their thoughts and any technical issues they faced during the trial period. The evaluator also had access to a class blog maintained by one class participating in the trial (Hovell Public School). This blog was used periodically

during the trial period to enable the students to reflect on their use of the iPad and capture their thoughts on particular apps. The blog posts were coded for any recurring themes and provided complementary evidence in the theme matrix.

App Matrix

All teachers who participated in the study provided details about all apps they used during the trial. Teachers described the app and how it was used, recommended age range of students that the app could be used with and classified the app according to Highfield and Goodwin's (2012) classification scheme described earlier in the section 'Classification of Apps'.

This data was entered in an Excel spreadsheet to allow for some quantitative data to be generated.

Limitations to the Study

A small sample size and brief implementation period limits the generalisability of this study to broader contexts. While the findings may be applicable to other contexts and support, extend or challenge previous studies, the specific findings may be unique to the actual sample examined in this trial. Given the small sample size of the study and brief time frame of the trial period, generalising or interpreting these findings as policy recommendations is cautioned. Transferability of these findings to other educational settings may not be plausible. However, the preliminary results suggest several interesting insights and some important lessons can be obtained from the shared experiences of trial schools and teachers.

A further issue associated with qualitative, exploratory research pertains to researcher bias. The selective use of data to elucidate particular findings may misrepresent the actual data obtained and mislead the reader. To overcome this limitation, specific instantiations of data were used and cross-referenced to other related incidents. This enables the reader to determine the possibility of researcher's selective bias. Transparent analysis processes and a trail of evidence also assist in nullifying the adverse effect of researcher bias.

A similar limitation associated with interpretivist studies pertains to conflating the findings. Brown (1992) cautions against 'romanticising' the novelty of findings. To overcome this limitation the researcher attempted to identify comparable studies where similar results have been demonstrated to confirm the results in this study.

As a review, some of the interview data from students and teachers may be attributed to the 'halo effect', as the CLIC staff members and external evaluator conducted the student and teacher interviews. The presence of CLIC staff members and the evaluator during site visits may have also impacted on the authenticity of the lessons observed. There is little that can be done to avoid this, other than to note this as a possibility when reviewing the findings.

Ethical Issues

All teachers involved in the study agreed to participate after initially being selected by their principal. Parental consent had been obtained for students who were interviewed and/or videoed during site visits. The external evaluator will retain video data for a period of five years on a DVD stored in a locked cupboard in their home office. It will not be distributed or shared in publications or conferences without the prior written consent of CLIC. A copy of all digital video files will be retained at CLIC in a locked cupboard.

Key Findings

This Evaluation is divided into two major sections as summarised in Figure 4.

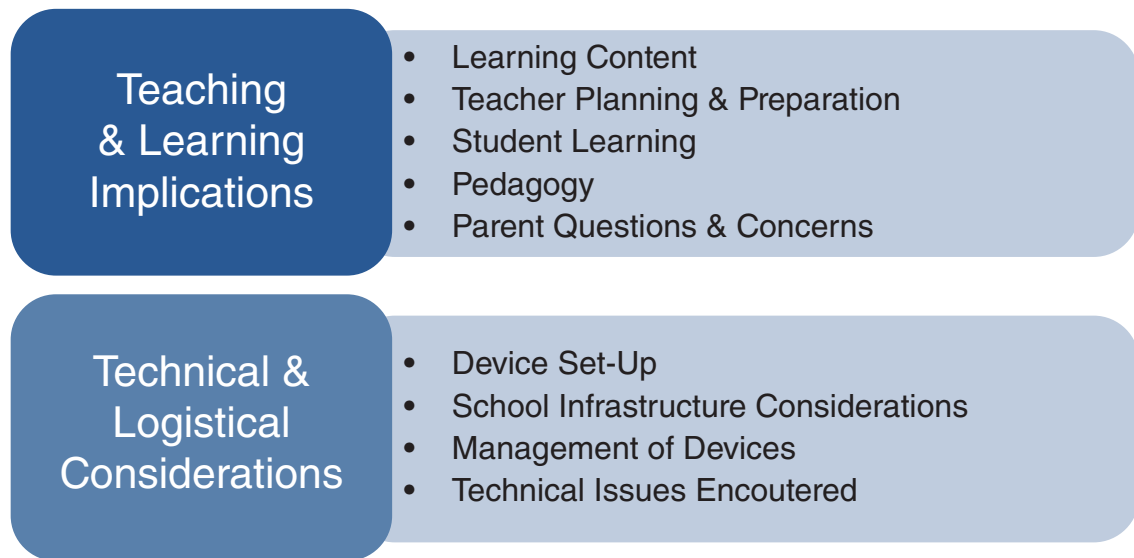


Figure 4. An overview of the evaluation

Learning Content

Seven broad themes emerged from the theme matrix that related to Learning Content.

Some degree of alignment between the apps utilised and the NSW BOS syllabus content

Three survey respondents reported that there was significant variation in terms of how well the apps aligned to the NSW BOS Syllabus documents. One teacher felt that the apps were very well aligned to the current syllabus and one teacher felt that there was little alignment. This problem was more pronounced when searching for content-receiving, drill-and-practice apps, where the content was embedded in the app and not constructed by the student, as is the case with 'productivity' apps. In the interviews, the teachers explained that there was an abundance of 'productivity', content-making apps that were more open-ended in their design. Therefore, the teacher determined the relevance of these apps to the curriculum. As Ben described in the interview, '...the productivity apps are to be used as you see fit'. The teacher must use their discretion and knowledge of the syllabus to locate these apps to suit the needs of the syllabus documents. However, the onus was on the teacher to source such apps and match these to their curriculum goals.

As Video 5 illuminates, the trial teachers also lamented the lack of Australian content within apps. This problem was amplified when using phonics apps where American accents were presented. In addition, there were some issues with apps using American spelling with some of the sight word apps and the use of the Imperial measurement system in some of the Mathematics game apps. Ben suggested that the DEC app, Schools A-Z had appropriate Australian content and recommended this as an app to download for NSW teachers. This finding corroborates findings from the Parramatta Catholic Diocese iPad trial where it was also found that there were limited apps with Australian content (Catholic Education, 2011).



Video 5. An absence of Australian content and accents is problematic

Teacher preference for content-creation apps rather than content receiving apps (except for rote memorisation of facts)

A common denominator in the teachers' survey responses and interviews related to their preference for content-creation apps, also referred to as 'productivity' or 'constructive' apps, instead of content receiving or instructive apps. The teachers suggested that the content-creation apps provided value for money as the app could be used across a range of subject areas, whereas content receiving apps were typically restricted to one subject area. Several teachers also alluded to the fact that the content-creation apps were more compatible with their pedagogical approach that was based, to some extent, on constructivism. The teachers explained that the content-creation apps enabled the students to easily create digital work that was indicative of their understanding. One teacher in the survey stated, 'I would continue to use open ended apps that allow the children to express themselves in creative ways across the KLAs such as Puppet pals, Toontastic, GarageBand Keynotes'. During the interviews, Neralie justified her preference for content-creation apps, saying that the, '...drill and practice apps became dry after a while'. Some of the content-creation apps used during the trial period and recommended for future use were Toontastic, Puppet Pals, Pages, Keynote, GarageBand, Show Me, iMotion and Strip Design. These apps are classified as constructive with the exception of Toontastic which is manipulable. Video 6 is an example of a piece of work created by two Year 3 students at Hovell Public School to demonstrate their understanding of various bones. Created with the constructive Keynote app, the students were able to easily share their knowledge about bones using text and digital photographs. This is an example of an app being used at the 'modification' level, according to Puentedura's (2006) SAMR model.



Video 6. A student work sample using the content-creation Keynote app

Most apps used in the trial followed instructive design principles

A matrix of the apps used throughout the trial period was constructed (see the Appendices). The purpose of this matrix was twofold: (i) to provide a list of educational apps for future iPad users and (ii) to classify the design of the app using the classification scheme developed by Highfield and Goodwin (2012). Of the apps used throughout the trial period, 43% were classified as instructive, 26% were manipulable and 31% were constructive. This data does not indicate the proportion of time teachers devoted to each type of app, nor does it suggest that instructive apps are the best design of apps because they were the type most frequently used. Instead, this data illuminates what many teachers have proposed and reported anecdotally: there is a preponderance of instructive games-based apps available in the iTunes App Store. If used as the sole type of app on iPads the potential affordances offered by the mobile device are constrained: it leads to a restricted use of the device which becomes more like a game console. If used solely to play instructive game apps, as Ben stated, 'iPads are an expensive gaming device'.

This finding reiterates earlier research conducted by Highfield and Goodwin (2012) where it was found that 75% of apps available in the 'Education' section of the iTunes store were classified as instructive. These apps were content-receiving apps based on the drill-and-practice paradigm. It is postulated that the design of many apps has been based on entrenched philosophical views of what constitutes learning which may be affiliated with more of a behaviourist approach (Highfield & Goodwin, 2012). In addition, the linear and prescriptive design of such apps may also be easier for developers than more open-ended apps.

iPad is an ideal tool to teach concepts or skills that require rote memorisation of facts

While it may appear to contradict the previous theme, teachers also saw the iPad as an ideal tool to support students' rote learning of facts. The teachers explained that Mathematics computation skills, such as recalling multiplication tables and addition facts and spelling skills, were well suited to the drill-and-practice apps, as the learning was disguised as fun (as summarised in Video 7). Melanie explained that the students would sit and constantly use the Times Table app to improve their recall of multiplication facts, but would never devote the same time to a worksheet or more conventional forms of teaching. Survey respondent three stated, 'The iPads have also made the drill and practise of basic maths facts more fun, rewarding and timely'. Interestingly, the students also indicated that they enjoyed using the iPads to consolidate their learning of facts and strongly believed that their learning had improved because of their use of such apps. Anna from

Hovell Public school stated, 'You learn your time tables on the apps and it's much easier than doing it on a piece of paper.' On the Hovell Public School class blog one student wrote, 'Hi, I love the Ipad (sic) because (sic) you learn from them by using the maths games'. However, during the interviews all of the teachers reiterated that although the use of content-receiving apps supported the learning of rote memorisation and recall of facts, they did not believe that this constituted the best use of the iPad. Ben claimed, '... it's good when used in moderation...but it would have been a waste to use them (iPads) as a games machine'.



Video 7. Teachers explain how iPads and content-receiving apps support the rote learning of facts

Perception amongst the teachers that the Mathematics KLA was not as effectively addressed as other KLAs when using the iPads

Despite the preponderance of Mathematics apps available in the iTunes store, several teachers noted that they felt that they had not used the iPads as effectively in the Mathematics curriculum area as they would have liked. They also felt that the quality of many of the available Mathematics apps was inferior to other subject areas and also the more open-ended constructive apps. Eric commented, '...they reduce maths because they do not build in any problem solving or open-ended aspects of Mathematics'. Survey respondent one also lamented, '...my pedagogy was insufficient to engage the kids in Mathematics in exactly the same way as the other KLAs'. With the content-receiving apps, the Mathematics often becomes superfluous to the game or activity upon which the app is based. For example, in the Rocket Maths app which was very popular with the students, the Mathematics was not as important as the design and construction of a rocket that the user could launch. However, Ben detailed how he used some more constructive, screen recording apps such as Show Me, Screen Chomp and Explain Everything to enable students to create video tutorials where they provided verbal and visual explanations related to Mathematics concepts. This presents a more student-centred approach to Mathematics instruction and is worthwhile considering as a viable alternative to simply using instructive, drill-and-practice apps.

The students had varying opinions about Maths apps. Of the 85 students surveyed, 25% identified one of the Maths apps, as the worst apps they had used during the trial period. One student responded, '...They are just too easy and boring'. However, other students liked the maths apps, one wrote, 'I like all the apps is (sic) because they all have different ways to help you in maths' (student survey response, question 7).

Users need to have control over entry points when using drill-and-practice apps

The teachers also mentioned that it was important to have control over the drill-and-practice apps. In particular, they liked to be able to specify the entry level for students to enable them to not only differentiate instruction according to a student's ability level, but to also avoid student frustration when encountering easy content. With some apps, teachers reported that each time the app was used, students were forced to start at the basic level and work their way to more difficult levels. This often resulted in students becoming bored and subsequently disengaging from the task. It is therefore imperative that teachers consider if they can specify starting levels when appraising drill-and-practice apps to use with their class. This finding has implications for both teachers and app designers.

Teachers sought apps that went beyond their counterpart desktop apps and incorporate mobile specific affordances

Many of the teachers wanted to leverage the unique affordances the iPad offered such as the tilt and movement functions and touch interactivity which provide enhanced and unique functionality, compared to a laptop or computer. Teachers sought apps that would allow students to experience these features but admitted that there were limited educational apps that offered them.

The Tilt to Live app was used at Hume Public School and the students all identified this as one of the best apps they used. Although not strictly an educational app it did, develop problem solving skills. During the student interviews, one student explained, '...when you tilt the iPad it goes that way and you have to avoid the red dots and you have power ups.'

The Fluid app also provided unique characteristics that could not be replicated on a computer. As a relaxation app, it provides calming music and scenery that can be manipulated by touching or tilting the device. The students reported enjoying this app because of its function (to provide relaxation), but also liked manipulating the iPad in new ways.

Eric also explained how the GarageBand app presented unique opportunities to learners to explore and create music. He detailed how GarageBand was already a great piece of software on a Mac computer but when used on an iPad, '...it becomes an amazing app' because of the touch aspect, immediacy of the response and the way it integrates with other apps.

In Video 8 Ben describes how the Maths Games app made effective use of the tilt function (accelerometer) of the iPad. Video 8 also shares some of the teachers' insights into the unique design features offered by iPads and specific apps. While apps are still in their infancy in terms of their design, developers are increasingly designing apps that make use of these unique features of the iPad. It is recommended that app developers further explore these possibilities, particularly with educational apps.



Video 8. Unique design attributes of apps that leveraged the features of an iPad

Teacher Planning and Preparation

Four themes were identified from the corpus of data collected relating to teacher planning and preparation required when using iPads.

iTunes reviews and teacher recommendations were common sources of educational apps

There was some commonality in the ways teachers located and reviewed apps to install on the students' iPads. Most of the teachers would do a general search in the iTunes App Store and read the customer reviews. They also stated that they referred to educational blogs of other iPad users: the Victorian iPad Trial website (<http://www.ipadsforeducation.vic.edu.au/education-apps>) and Learning and Teaching with iPads Blog established by the Catholic Education Office in the Parramatta Diocese (<http://learningwithipads.blogspot.com/p/ipad-learning-links.html>) were two sites mentioned. Teachers also reported that they relied on emails that alerted them to educational apps and verbal recommendations by other teachers, their students and parents.

After locating apps that may be suitable, teachers would typically download the lite version of a paid app where possible. They would use the app on their iPad before installing it on the students' devices. If only paid apps were available, the teacher would install it on their device and trial the app before committing to a class purchase. Several teachers mentioned that it was important to trial the app before using it with students to identify any technical issues and errors and consider its educational value. Teachers stressed that it may prove costly to install apps on students' devices that are not pedagogically sound. There were some technical issues with some apps not working at school, despite having worked when the teacher trialled the app at home on the same device. This occurred only with apps requiring Internet connectivity because the DEC Authenticated Proxy was a barrier for apps in iOS4 that do not cater for authentication. The teachers reported that this problem appeared to have been rectified with the installation of iOS5 but explained that they had not yet been able to check all the apps that required an Internet connection.

Additional preparation required by the teacher to use iPads successfully in the classroom

Given that there are 50 000 apps currently available in the iTunes Store, it is not surprising that teachers reported that they spent a lot of time searching and trialling appropriate apps to use with their students. This had obvious ramifications

for the amount of time devoted to planning lessons. However, all trial participants stated that they did not object to the extra time requirements for lesson preparation as they saw how valuable the devices were in supporting students' learning. It is important to note that this favourable response to extra preparation time may not be replicated in other contexts, as the teacher participants were considered to be a very dedicated group of teachers who demonstrated proficiency in technology use. Time spent circumventing and rectifying technical problems and collecting and uploading student work was indicative of their high levels of professionalism and dedication.

Teachers integrated the iPads into their teaching and learning programs in myriad ways

Based on the lessons observed during the site visits and the teachers' survey and interview responses, it was apparent that the iPads were used to support a diverse range of learning experiences. Figure 5 summarises the types of activities undertaken on the iPads. They were used in whole class, individual, dyads, triads and small group contexts, regardless of the ratio of iPads to students. While Hovell Public School used a one-to-one model and students predominantly had individual use of the iPads, there were still opportunities for the students to work in pairs or small groups. Interestingly, the teacher at Hovell Public School noted that despite the individual use of the iPad (one-to-one model), collaboration and student dialogue had actually increased in the classroom (see the section 'Enhanced collaboration and communication between students').

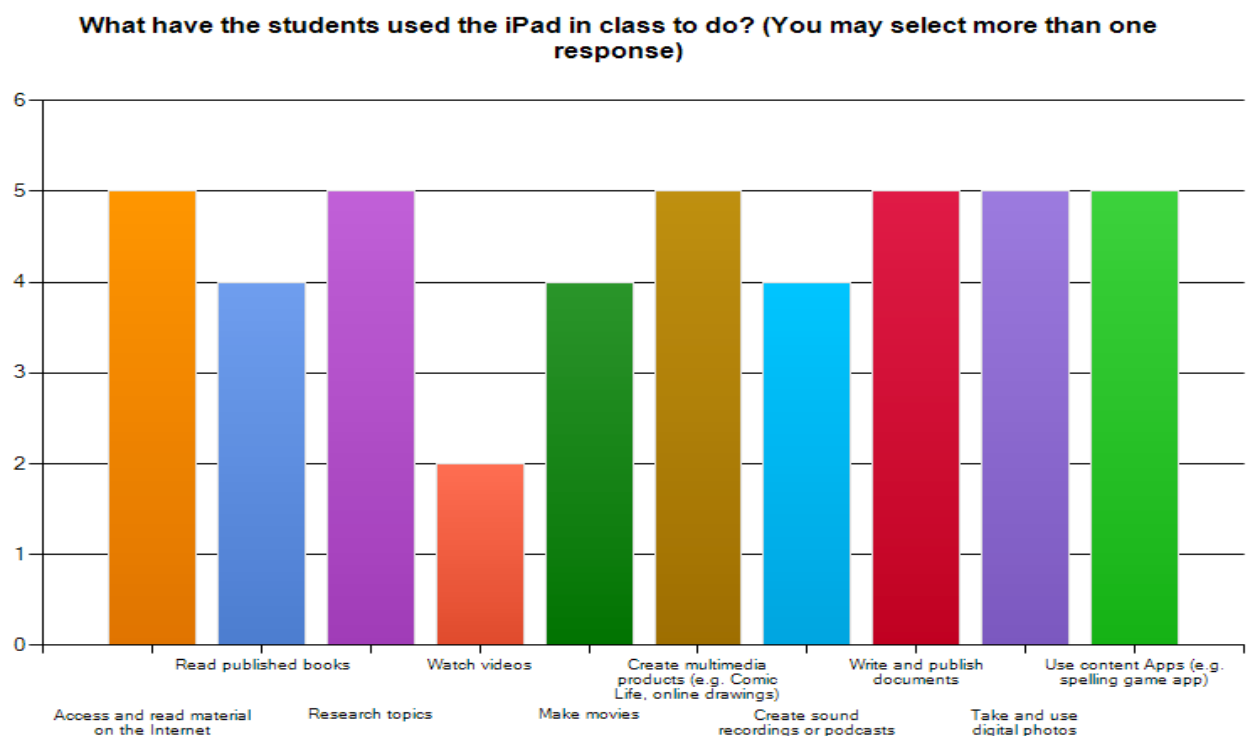


Figure 5. A summary of the types of activities students undertook on the iPads throughout the trial period

One survey respondent's description of a typical lesson is detailed in Vignette 1 and highlights one way in which the iPad was used.

'Given the myriad of ways the iPad has been used, there has been no 'typical' lesson. That said, a typical maths lesson starts out with a ten minute introduction of the concept. Students are then split into four groups, one of those groups using iPads. The others doing a range of maths activities relating to the concept. The iPad group will either be explaining the concept using an app set by the teacher or they will be completing drill and practice games (depending on the concept). After 20 minutes the groups will rotate. The lesson will conclude after two rotations but the activities not completed are completed the following day. As a conclusion some students will share their work, explaining the concept. If it is work done on the iPad, this is shown on the interactive whiteboard. The teacher and other students check for understanding.'

Vignette 1. A survey respondent's description of a 'typical' lesson with an iPad.

A typical lesson is also showcased in Video 9. It shows how the iPad was used as a tool to support a range of student-centred learning experiences and how the iPad was used in tandem with the IWB.



Video 9. A 'typical' literacy lesson in Eric's classroom which made use of the iPads

Trend to map new technologies to old curricula but use innovative pedagogies

Throughout the teacher interviews and surveys it became apparent that teachers used the iPad to support traditional curricula but used more innovative pedagogies. It has been proposed that too often new ICTs are mapped to old curricula and are often used in restrictive ways because they perpetuate didactic pedagogies (Yelland, 2007, Yelland et al 2008). However, in this trial it appears that the teachers used the iPad as an impetus to promote more student-centred and engaging pedagogical approaches. It was evident that the teachers felt somewhat restricted because they had specified learning outcomes to address. However, they saw that the iPad presented new opportunities for establishing more student-centred, constructive pedagogies. All teachers mentioned the need to map the iPad to the syllabus documents. One survey respondent stated, 'An app needs to be found to suit the curriculum'. Typically, they would examine the syllabus and then determine how they would go about teaching this content or skill and then select the most appropriate app/s to facilitate this. Ben explained, '...you need to think of new ways to deliver content'. Video 10 elucidates how the teachers involved in the trial sought new pedagogies to deliver the curriculum using the iPad as a tool.



Video 10. Teachers explaining how they sought innovative pedagogies to accompany iPad use

Student Learning

There was a plethora of themes that related to student learning when using iPads. Most of these themes related to how the iPad was used as a tool to facilitate learning. It is important to note here that this trial did not seek to provide empirical evidence to show that iPads enhanced learning outcomes. There was no use of quantitative data to measure students learning with iPads. Instead, the focus of the trial was examining the practical use of iPads in classroom settings and detailing the ways in which the device facilitated and/or impeded student learning. Again, it is critical to acknowledge the important role that teachers play in determining the benefits accrued from the iPad. It is not so much the iPad that caused these changes in student learning, but the manner in which the teachers encouraged the students to use the device.

Increased engagement and motivation

A recurrent theme throughout many of the data sources was students describing the iPads as 'fun'. The iPads were closely aligned to students' digital culture. When justifying their choice of their favourite app in the online survey, 21% of respondents used the word 'fun' to describe their chosen app, as shown in Figure 6.



Figure 6. A cloud summary and percentage analysis of students' explanations as to why they liked a particular app

Data obtained from the lesson observations, student interviews and surveys confirmed that the students considered the iPad as a helpful learning tool and one they enjoyed using. It can be inferred from many of the students' comments

that they did not typically associate school and learning with 'fun,' as illuminated in the Video 11. This may have in turn accounted for the increase in their engagement and motivation.



Video 11. The iPad as a 'fun' device

In fact, all teachers involved reported that students' engagement and motivation had increased exponentially throughout the trial period. It was postulated that the increase in motivation had prompted the increase in student engagement. In all lessons observed during the site visits, student engagement was exceptionally high. There were few incidents of off-task behaviour observed. The teachers confirmed this finding, proposing that the quick start-up of the device, as compared to the time required to start a computer and the easy and instantaneous way in which students could access and produce information, contributed to the students' increased engagement. One of the survey respondents stated, 'With technology at their fingertips all day it empowers them (sic) to gain new information and IT skills at an amazing rate. They are more inquisitive and eager to see an image or learn a definition at a click of a finger.' Again, the quality of the task design and not the iPad itself, accounted for the gains in student learning, as several of the principals qualify in Video 12, below. The immediacy of mobile devices is one of their key affordances.



Video 12. The teachers describing the students' increased motivation and engagement

Balance between motivation and critical content learning when using the iPads

Four of the five teacher survey respondents agreed that there was usually a balance between motivation and content learning when using the iPads. Whilst increased student motivation is assumed with this device, the absence of the

novelty factor may suggest that the students perceived that they were undertaking meaningful tasks with the iPad. Several teachers and principals also stressed that it was necessary to critically consider the use of the iPads as it was pointless to use the device because it was available. As Ben described, today's students are technologically-savvy and, '... quick to ascertain if products are quality, not just electronic gimmicks.' One of the principals, Steve, highlighted the importance of, '... being critical about the iPad as the best tool for the job.' Therefore, the onus was on the teacher to select educationally sound apps and include these in meaningful tasks that appealed to learners. Unless the device and the selected apps were engaging the students would not continue to display the high levels of motivation as they did in this trial.

Improved student knowledge and skills

Although not formerly measured in this trial, all teachers reported that they had observed improvements in most students' learning, throughout the trial period and attributed this to the use of the iPad. Ben stated, 'The iPads have had a really profound impact on learning in my class... I have seen steady increases in their knowledge in maths and their confidence in maths and that is because I spent a lot of time planning my lessons around the iPad.' Ben's comment clearly articulates that the students' learning gains were a result of his (the teacher's) thorough planning and careful consideration of how to devise the best learning setting supported by the iPad. Use of an iPad alone will not guarantee improved learning outcomes. The pedagogical structures that support its implementation determine its effectiveness.

Student perception that the games 'taught' them things particularly with maths and writing

The students also identified that the iPad had aided in improving their knowledge and skills, particularly in the Mathematics and English curriculum areas. There was a strong association between learning and maths in the students' survey responses and interview data, possibly because of a student perception that Maths is tangible evidence of learning taking place. One student from Hovell Public School provided the following explanation on their class blog, 'Hello I love using the Ipad so much, the reason why is because (sic) there is so many apps to choose from like GarageBand and Keynote- those are my favourite two. I think using the iPad is very helpful in my learning.' Interestingly, in the surveys and interviews many of the students described how the Maths games (instructive apps) 'taught' them skills. Opportunities for repetition and the provision of instant feedback were frequently mentioned when describing Maths game apps. One student explained how the Factor Samurai app assisted him recall factors of given numbers, 'If you get it wrong you lose a life and if you get it right you get a different sword'. Another student explained, 'Things that you do on the games make you want to learn the Maths'. Video 13 demonstrates how the students believed the iPad had assisted with their mathematical learning.



Video 13. Student explanations for how the iPad has assisted their learning

The Mathematics KLA was the most frequently cited subject area where the students believed the iPads had helped them to learn. During the student interviews, many of the students clearly described how their recall of multiplication facts and mental computation strategies had improved as a result of using particular Maths apps. One survey respondent wrote, 'The iPads have helped me to learn a lot in class. I believe that with the iPads I have improved with my maths skills e.g. now I know the answer timetables much quicker, I am able to share my work with others and be able to help them.' Interestingly, 44% of the students used the word 'maths' and 20% used the word 'tables' to explain how the iPads had helped them learn (as shown in Figure 7). Students' preferences for apps are described in more detail in the following section, 'Student Learning'. Whilst the recall of basic facts is not the 'optimal' use of the iPad ('substitution' and 'augmentation' levels according to the SAMR model), it was interesting to note that the students felt empowered because they had easily acquired these skills. These findings may be more a reflection of the students' restricted notion of the term 'learning': their conceptions of learning might be strongly connected to rote learning of facts.

Apps Dictionary Easier Group Work Helped me Learn Internet iPads Learning Fun Maths

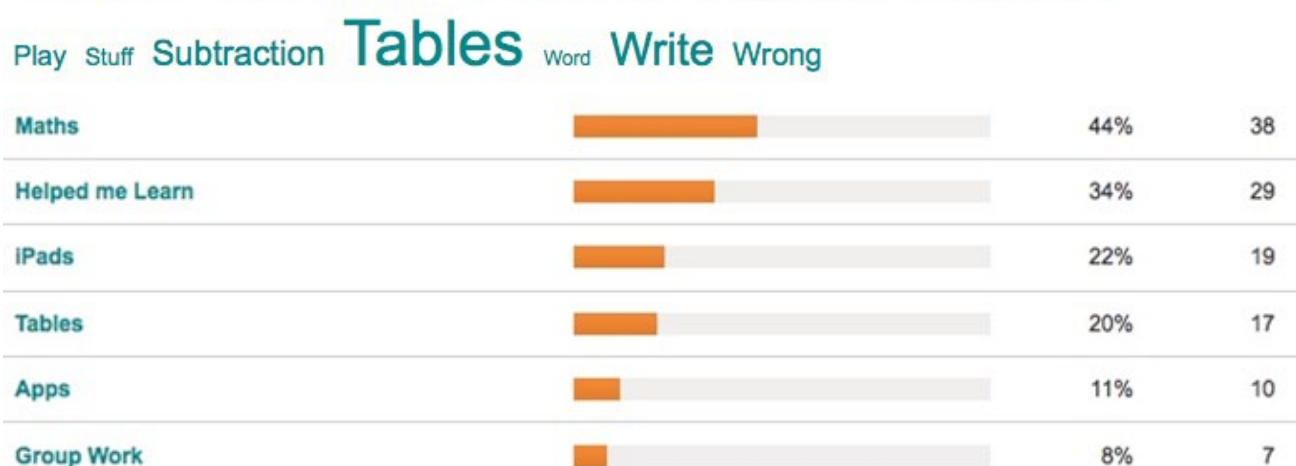


Figure 7. A text analysis (cloud view and list view) of students' responses to the online survey question asking how the iPads had helped them to learn (question 5)

It may be possible to attribute the students' perceptions that their learning had improved as a result of iPad use to a novelty factor or perhaps to the halo effect. It is also important to consider the social desirability attached to using an iPad and how this may have shaped students' perceptions of the device. However, the teachers also stated that the students' confidence as learners had improved over the trial period and had not appeared to wane in the given timeframe. Perhaps a longer trial may provide evidence of a novelty factor. One of the principals interviewed stated that the novelty factor had not been present over the trial period unlike other technologies that had been previously implemented at their school.

Enhanced collaboration and communication between students

One of the reasons cited by the teachers to account for the improvements in students' learning related to the increased levels of collaboration amongst the students. This finding was echoed in both the one-to-many and One-to-two settings. While the one-to-two scenario naturally elicits collaboration, the one-to-one model does not. However, Amanda explained that there were high levels of collaboration observed in her class, even where a one-to-one model was utilised. Ironically, the teachers believed that the iPad actually improved collaboration and communication between students as they had something meaningful and tangible to discuss. Once again, Eric identified that it was the design of the task and not the device per se that facilitates collaboration.

Green and Hannon (2006) referred to today's students as 'everyday communicators' and this was evident in the trial. The teachers explained that both face-to-face and screen-based interaction had increased substantially throughout the trial. One of the chief ways the iPad afforded face-to-face collaboration was through students sharing technical solutions to problems and novel ideas on how to use the device. As Amanda describes in Video 14, when students discovered a new function on the iPad, there was a domino effect, where new information was discovered by a student and then 'ripples' followed around the room. Other teachers involved in the trial also talked about how the students were eager to share new technical solutions and app functions they had discovered. As Melanie describes in Video 14, the iPad provided a meaningful context for the students to share and discuss new ideas as compared to other lessons that used more traditional materials.



Video 14. Increased collaboration between students when using the iPad

Collaboration was also provisioned through the constant sharing of student work usually via the IWB. In one of the lessons observed at Eyre Public School the students used the document camera which was attached to the data projector

and IWB and shared work they had produced on the iPad. Their peers provided feedback in the form of 'Stars and Wishes.' This scaffolded feedback provided the students with opportunities to reflect on their work and the teacher with meaningful and formative assessment data (see the section 'Sharing work and just-in-time feedback').

'We used a one-to-two model, so there were 15 iPads per class. This meant that students were always collaborating when working with iPads. Also the nature of the activities available on iPads supports collaboration. The students are constantly learning how to use new apps or get different products from apps that they have used before. They do this by working together. Students want to see what someone else is doing on another iPad so much more than they want to see what someone else has done in their workbook.'

'We had a rule that if students learnt a new skill they had to share it with three other students in the room. Often a new thing was discovered (sic) and it moved around the room with a domino effect.'

'They turn to each other to see and share what they are doing. They turn to each other for help and to show new features they have found. They discuss and show what they have done.'

Vignette 2. Teacher survey responses showcasing examples of how collaboration had increased

Online learning experiences also enhanced the students' screen-based interactions via asynchronous communication. At Eyre Public School, as part of the literacy lessons observed, students would respond to a post the teacher had created on Edmodo (a social learning network for students and teachers). They were given a hyperlink to a short video to watch on the iPad and then they needed to formulate a response to the teacher's post related to the video. The teacher explained that this task would be onerous to replicate without the iPads as the computer room would need to be booked. The iPads allowed for instant access to the Internet and asynchronous communication to occur via the social learning platform. These are fundamental skills required for 21st century learning and the iPad enabled them to be developed with ease.

Learning for students easy to personalise

There was an overriding sense amongst the teachers that the iPads made it easy to personalise learning. In doing so, it made learning more authentic for the students and provided a relevant purpose for learning. As a result, there was a strong sense of student ownership of their learning. The teachers explained during the interviews that it was much easier to personalise learning when using an iPad, as compared to other technological tools. For example, Eric explained that his Year 3 class had used the iPads to create multimedia book reviews as part of their literacy rotation groups. The students were able to select their own book and then elected to use the iMovie app to create a review that included images from the Internet, their voice recordings (if they elected to), written text to complement the images and music. One survey respondent described, '... the iPad allowed them to easily create visually appealing stories, augmented by pictures and video.' While this task could be replicated on a personal computer, the seamless integration of apps on the iPad made the task a lot easier. This is a prime example of a 're-defined' learning task, using the SAMR model (Puentedura, 2006).

In the one-to-one setting personalisation was also easily facilitated because the teacher could install specific apps onto students' devices. This enabled her to select apps that were appropriate for that student, rather than having a generic installation of class apps or computers with identical software.

Students were also frequently provided with opportunities to select the app/s to undertake a task. The students became discriminate users of the apps and were able to select the best app for the task. This empowered the students and provided an authentic opportunity for learning to be highly personalised.

Ease of differentiation

For similar reasons, as previously described, curriculum differentiation was also easy to address in a class setting when using an iPad. Amanda explained that the design of the tasks and the selection of apps made the process of differentiation easier than it is without an iPad. Open-ended tasks allowed for students to demonstrate their understanding in a multitude of ways without imposing limits of what they are able to produce, as is often the case with a worksheet. Video 16 shows a lesson observed at Hovell Public School where the students used the i-nigma app to read their task which involved investigating and preparing a presentation on the names and attributes of 3D shapes. The students were able to select the most appropriate app for the task which was sufficiently open-ended to allow for a range of responses. It was interesting to note that one student investigated the name of a ten sided shape during the lesson by using the Safari app and reading relevant information. Both his teacher and the Computer Co-Ordinator who was also present, noted that a traditional lesson with a worksheet or concrete materials may not have allowed for this exploration and discovery. Neralie explained that this is why content-creation apps were superior to drill-and-practice, content-receiving apps: the content-creation apps did not impose a ceiling on what the students could do, whereas most of the game apps restricted students' learning to the predetermined responses that had been programmed by the app developer.



Video 16. A maths lesson involving 3D shapes, observed at Hovell Public School

One teacher survey respondent stated, I was able to put specific apps onto different iPads to match the different abilities of the students in my class. Melanie also explained that differentiation was easier because she could easily select and install apps for specific students. She also explained that it was possible to differentiate within some of the games-based apps as they had levels: a specific level could be prescribed for students according to their ability and/or needs. Ben provided a practical example of how he catered for varying student abilities within his class by using the Khan Academy videos during Mathematics lessons.

Students could watch and replay videos of mathematical concepts if they required extra scaffolding. While Ben acknowledged that this did not make the teacher redundant, it did provide students with opportunities for extra help in a non-confronting fashion.

The curriculum was also easily differentiated because the teachers allowed the students to select the most appropriate app for some tasks. The students were able to demonstrate their learning in different ways thus catering for a diversity of preferred learning styles and modes. The apps appealed to visual learners (vibrant photographs and pictures, dynamic images and representations, videos), tactile learners (using their fingers to manipulate objects) and auditory learners (inclusion of music, speech and read aloud functions). Thus, the iPad supported a variety of learning styles. Amanda highlighted how the apps provided different opportunities for students to express their ideas and catered for their preferred modes of learning. She explained that using the iPads allowed her more introverted students the opportunity to share their ideas. Students would use an adjacent room as a recording lab and record their voices onto apps such as Keynote, Puppet Pals and Toontastic. Previously, these students would have avoided presenting their work to the class. However, with an iPad, these students were eager to present their work. 'I have seen a side of children that I otherwise would not see.'

Students enabled to easily produce a professional finished product

Many of the teachers explained that student learning had been enhanced because the iPad was a suitable augmentation tool. It enabled students to easily produce professional and aesthetic work they may otherwise not be able to produce with more traditional media such as pencil and paper. The students were able to easily produce animations, music, videos, artworks and online tutorials. One of the teacher survey respondents stated, 'It is much easier to create visually stunning content that students are more engaged and motivated to create.' The iPad allows students the opportunity to produce work that they are proud of which, in turn, boosts their self-esteem. It also enabled them to produce work that is indicative of their true levels of understanding and not inhibited by their literacy or fine motor skills as is often the case with more traditional learning experiences that use other media (such as worksheets). In the student work samples below, the students were able to leverage the affordances of the iPad to present professional looking work. In Video 17, a Year 3 student retold the story *Are we there yet?* using the Puppet Pals app. The finished product, a movie, is creative and enabled the student to convey their ideas predominantly through spoken text.



Video 17. An oral retell of the story *Are we there yet?* using the Puppet Pals app

Two other student work samples are provided below in Figure 8 and Figure 9. Created by Year 6 students from Eyre Public School, these examples are emblematic of the high quality of work produced on the iPads throughout the trial period. Figure 8 is an artwork created using the iPerbolic app and Figure 9 is an advertisement for a school fete using the Phoster app. While it may have been possible to complete similar work using a computer, there would have been a series of other intermediary steps involved and/or specialised software installed. However, the students were able to easily create these digital artefacts with the iPads, without having to download and insert photos and using apps that cost no more than \$1.99 (Phoster app). The pride most students in the trial had in their work was shown by their eagerness to show it to the CLIC staff members and evaluator at the three site visits.

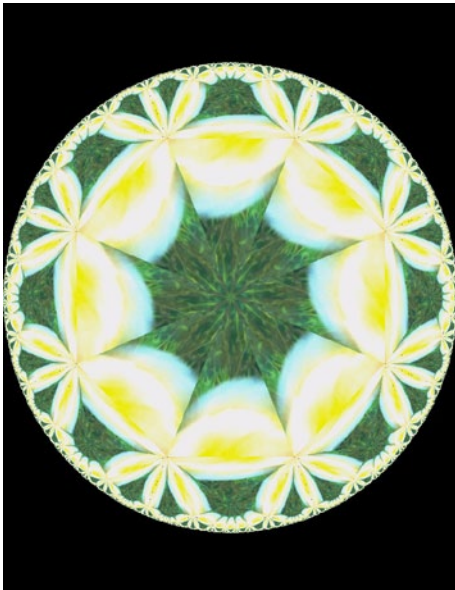


Figure 8. A student work sample created using the iPerbolic app



Figure 9. A student work sample created using the Phoster app

A further example of students creating content that they otherwise may not be able to create with traditional media or which may be too tedious to create with computers and software programs is in Video 18 where a student showcases a screen recording app, Screen Chomp, and explains how she used it to provide

verbal instructions to travel to the local shops. This video exemplifies that the task was meaningful and the iPad (and appropriate app) allowed the student to authentically demonstrate their understanding. This is a prime example of the iPad being used to 'redefine' learning experiences, according to Puentedura's (2006) SAMR model.



Video 18. A student provides verbal directions captured using the Screen Chomp app

Developing skills scaffolded and compensated (ideal for reluctant writers)

A recurrent theme in the data set related to the ways the iPad supported students' emerging skills. Many of the teachers and principals also mentioned that the iPad was a great tool for reluctant writers, perhaps because of the additional scaffolding it provided. The teachers and students noted that the iPad and particular apps supported students' spelling skills and also reduced the physical demands of handwriting. One of the teachers stated in the online survey, 'Students unequivocally engaged with literacy using the iPads in my class. Students used iMovies to create book reports with running commentary of their audio and captions of their analysis of the books. Also, creating their stories using Pages augmented by Safari (Google Images) highly assisted their ability to plan, imagine, write, edit and re-write their narratives. The ability to use any image, video and audio to place in their story spurred a writing frenzy amongst my entire class over the two terms I had the 15 iPads.'

In particular, the students noted that the iPad supported their writing and spelling skills. As Video 19 exemplifies, the students were pleased that their spelling was supported with an iPad in ways that cannot be replicated with pencil and paper or even on a computer. The inbuilt spell-check function and predictive text enabled the students to identify and remedy mistakes instantaneously without the need for a dictionary. One student remarked, 'it's easier to write on your iPad...because if you don't know the word you just type it in and it tells you the word in the bottom.' Another survey respondent explained, 'They have helped me learn some more of my maths and my writing because if you make a mistake it will change it into the correct answer (sic).'



Video 19. A video summarising how the teachers and students believed the iPad scaffolded and supported their learning

The iPad also has the potential to remove any other impediments to producing written work such as poorly developed fine motor skills. Often handwriting is a tedious task for such students and they are unable to produce work that is truly indicative of their ability. However, with the iPad, the students were able to complete greater volumes of work. The teachers also confirmed this finding stating that the students produced greater volumes of work on the iPad compared to what they completed in their workbooks and explained that it took the students less time to produce work on the iPad. The students also found it quicker to type than to write and several students who were interviewed commented on the increased length of their written work on the iPad compared to bookwork. One of the students interviewed at Eyre Public School proudly proclaimed that he had written over 1000 words using the Pages app. He explained that he would never have written that much had he used pencil and paper. Many of the students claimed that the iPad was easier than using pencil and paper. One student explained in an interview, 'It makes it seem more interesting and less tiring...well we don't have to keep sharpening our pencils and we don't need to use rubbers'. Students also acknowledged that their learning had improved as a result of using the iPads, as is summarised in Figure 10. Haman's (2010) study identified that the sophomore students in the Ohio trial of iPads also wrote substantially more when using an iPad.



Figure 10. A student work sample summarising the student's perception of the benefits associated with using an iPad

The experimental nature of the iPad also encouraged the students to try things they may otherwise have not have tried. There was a sense of a lack of permanency, as the students explained that it was simple to rectify a mistake: 'You don't need rubbers and stuff. If you stuff it up, you just go 'click' and it's fixed.' Again, the immediacy of the device empowered student learning.

Strong sense of student ownership of the iPads

There was an overriding sense of student ownership of the iPads, even in the one-to-two setting. Many students had personalised the desktop with their own images and folders. There were no reports of any damaged devices throughout the trial which may reflect the robust design of the iPad but could also indicate that the students were careful when using the devices. Anecdotally, at the site visits, many of the students reiterated to the evaluator and CLIC staff members that they did not want the iPads to be taken away from them at the conclusion of the trial.

Technology as a tool metaphor

In the teacher interview and survey data there were constant references to the iPad as an ideal technological tool to support learning. In this sense, the teachers viewed the technology as something the students would learn with and not from. This is more than a subtle difference: teachers who believe that students learn with technology use substantially different pedagogical approaches to those who believe they learn from technology (Jonassen, Peck & Wilson, 1998). In many of the lessons observed, the students used its embedded features to solve problems as they arose. For example, a student did not know how to spell a word correctly while using the Pages app and simply highlighted the word and used the Dictionary app to confirm the correct spelling.

Embeddedness and seamless use of technology

The iPad was used regularly in teaching and learning activities. In the lessons observed it was used seamlessly as a tool to perform a specific function at a specific time. The students used the devices to fulfil particular needs as they arose. It was an organic and natural use of the technology, not imposed on the learners. This is in stark contrast to how laptops or banks of desktop computers are often used in a classroom setting where thorough planning is required to ensure that there will be sufficient student access to laptops or desktop computers and there is a lag time to start these devices. In contrast, the iPads could be easily used as the opportunity arose. As they were always ready for action, they were in constant use. As Cathryn, the Principal from Eyre Public School explained during her interview, 'It is content driven rather than device... iPad driven...the devices a great way... is still a tool'. Hence, the curriculum drove the use of the iPad and not the converse where the iPad dictated how the lesson was conducted. This is a critical difference which may account for why the teachers believed the iPad made a positive difference to student learning.

Instant access to provide just-in-time learning

The teachers identified the portability of the iPad as an enabling factor that supported students' learning. The students could access the Internet wherever they took the iPad in a classroom (within reason). This instant access, described above, is one of the chief iPad characteristics that appealed to the teachers. Quick access to a plethora of digital tools and immediate access to the Internet were cited as features of the iPad that supported and changed the ways students learn. Today's learners are accustomed to instant gratification from their daily

pursuits: they can download music instantly, play online games and see the correct answer appear, can scan objects at the supermarket and search for images and videos on the internet. While some psychologists question the need for instant gratification, it can benefit learning by preventing incorrect concepts being perpetuated and it forces students to reconcile errors. It also fosters engagement and minimises disruptions to learning. The teachers reported that substantial incidental learning had occurred throughout the trial period as students were able to search for extra information on the Internet while preparing a presentation. This allowed for tangential learning: something that is difficult to accommodate in a 'traditional' classroom, where there is limited and/or slow access to technology.

The mobility of the iPad allowed students to easily and quickly access current and relevant information. For example, Melanie explained how one of her students was completing an online crossword as part of their regular spelling activities. When they didn't understand a phrase they decided to use the Wolfram Alpha app to search for the correct answer. Students instantly satisfied their need for information which allowed them to continue with their work without further distraction. This may also account for increased engagement. Ben also explained how having Internet access transformed learning, 'Having the internet at your desk in a pad that's this big is really, really powerful'. Another teacher survey also noted, 'Firstly the iPads allow the students to access required information from their desk in a timely manner. I don't need to book the class into the computer lab or wait until an individual student has logged into a computer, the information is there, whenever it is needed'.

No observed gender differences in how the iPads were used but notable differences in preferences for app selections

There were no observed differences in how boys and girls used the iPads in class. The teachers also confirmed this finding. However, there were notable differences between boys and girls in their preferences for the types of apps they used during the interviews and observations. The boys tended to like the game apps whereas the girls tended to like the content-creation apps. Ben explained how the boys in his class liked the Maths Ninja app more so than the girls. Ben speculated that it was perhaps the violent content that appealed to the boys. Given the small sample size it would be premature to suggest that these are entrenched differences but this data certainly suggests that further investigation is warranted.

Preference for content-creation apps

Analysis of the students' favourite apps, as identified in the survey, revealed that 53% of students preferred constructive apps (content-creation), compared to 36% preferring instructive apps (content receiving, game apps) and 11% preferring manipulable apps (scaffolded, content-creation apps). This is reflected in Figure 11. When grouping the constructive and manipulable apps together, as both of these enable content-creation, it is clear that a significant proportion of students preferred to use these 'productivity' tools, as opposed to using the drill-and-practice game apps. Sixty-four per cent of students surveyed indicated that they would prefer content-creation apps over content receiving apps. This finding has important implications for app developers and also for teachers when selecting apps.

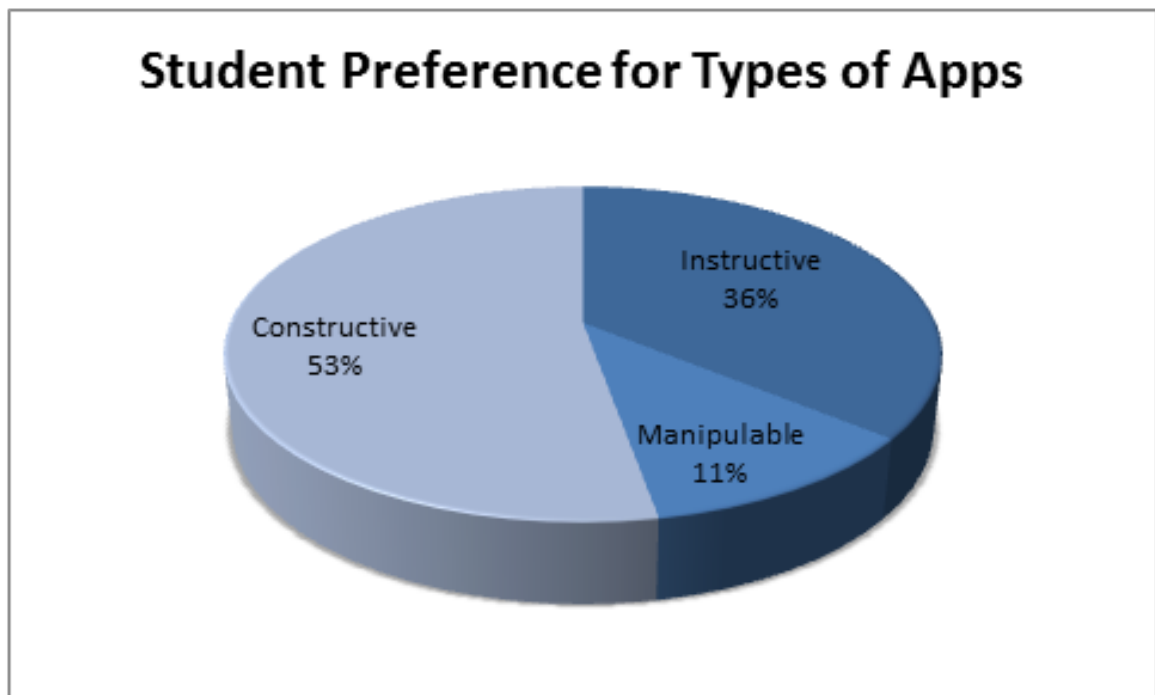


Figure 11. Student preferences for different types of apps

During the observed lessons it became apparent that levels of interactivity elicited by the app determined its ultimate success. Students expected to be actively involved while using an app particularly with content-receiving apps. Similarly, students wanted to be appropriately challenged when using an app. If an app was too onerous or not intuitive to use, the students would disregard the app and disengage. With games-based apps many student stated that they would not play a game if they perceived it to be too easy. In many of the student interviews and in the lessons observed, the students hankered after an appropriate challenge. They did not want to use an app that was too easy. At Hovell Public School, many of the Year 3 students stated that they did not like the Miss Spider's Tea Party app because they considered it too easy and it had limited opportunities for interactivity. As one student explained in their interview, '... all you do is read. You don't get to do any fun things. It's boring'. Regardless of the type of app the students preferred— content-receiving or content-creation— it was paramount that they were cognitively challenged and actively involved. Without this level of interaction and challenge the students would disengage. Once again, this highlights the critical role of the teacher in identifying appropriate apps and levels within apps (where appropriate) to ensure the instructional needs of the students are met. Video 20 provides additional insights into students' preference for content-creation apps.



Video 20. Student explanations for why they liked using content-creation apps

Competition element, instant feedback and levels critical in the appeal of game apps

Many of the teachers were surprised to see that the students enjoyed using the game apps as much as they did. The design of game apps as a content-receiving app is aligned with behaviourist philosophies which are antithetical to the pedagogical approaches the teachers employed in the iPad trial (and often preceded the trial). Often during free time students would gravitate towards playing the game apps. This may be because the game apps were aligned to the students' gaming culture. The interviews with the students suggested that the provision of competition, instant feedback and levels were critical to the appeal of game apps. Ben explained how he created a Leader Board in his class to foster the sense of competition when using particular game apps. The students reported enjoying beating their own score and that of their peers. The teachers also reported that the apps that provided scores or levels provided quantitative evidence to the students about their performance. In turn, this encouraged them to improve their performance and may also account for their increased levels of engagement and motivation.

The teachers noted that the provision of instant feedback and competition had encouraged the students to persevere with tasks that they may otherwise have disengaged with, as exemplified in Video 21. The overt display of immediate feedback also proved to be rewarding for the students. Instant feedback is critical in subject areas where students are required to master specific content, for example, spelling, multiplication tables and phonics. It enables students to identify and rectify mistakes in their thinking before they become misconceptions. The feedback was also individualised, in response to student input. The quality and level of individualised feedback cannot be easily emulated in a traditional classroom with one teacher and many students. One student explained how she used the Math Bingo app and liked knowing if her responses were correct: 'You have to get the right answer and if you get five in a row and you get Bingo and you get a Bingo Bug...if you get it wrong it just does another one. You've got to get it right. I love making my bingo bug!' Another student stated in the survey, 'They (game apps) make me faster and they tell me if I am right or wrong.' One concern with the use of rewards was the students' reliance on extrinsic motivation. They frequently reported that they liked particular apps because after they had correctly answered a predetermined number or percentage of questions they could then design a rocket (as in Rocket Maths app) or decorate bingo bugs (as

in Bingo Maths app) or engage in a fight (Math Ninja app). In these instances, the learning was often segregated from the reward. For example, the maths was divorced from the fighting in the Math Ninja app.



Video 21. The importance of competition, instant feedback and levels in game apps

Transformative models of technology integration provided by teachers' use of the iPad

As described in the Literature Review, teachers' levels of technology integration can be classified on a continuum using Puentedura's SAMR model (2006). In the lessons observed in the iPad trial and from the descriptions of lessons the teachers provided, many of the lessons using the iPads could be categorised at a 'modification' or 'redefinition' stage. The teachers devised tasks with the iPads that were completely novel (redefinition) or significantly redesigned tasks (modification). An example of a learning experience that was redefined using the iPads was observed at Eyre Public School and shown in Figure 12. Displayed in the school's foyer were student dioramas of animal habitats and attached were QR codes that could be scanned by students, teachers, parents and visitors to the school using any mobile device with a QR reader. The QR code directed users to a website (a wiki) that the students had created to provide additional information about their chosen habitat. Some of the wikis included videos and other multimedia resources that would be impossible to capture in a static poster. This is a prime example of how the iPad enabled the students to undertake a completely new task that may have previously been inconceivable and impossible to accomplish.



Figure 12. Examples of the student dioramas and QR codes displayed in the Eyre Public School foyer

QR codes were also used at Hovell Public School during a Human Society and Its Environment lesson. Video 22 shows how the students used the iPad and the i-nigma app to scan QR codes and read information about particular products. Also in Video 22 students are seen using the GarageBand app. In doing so, it shows how students are easily able to compose and record their own music, something that would be difficult to replicate without an iPad. It is evident that the students were highly engaged in both of these tasks. This transformative model, according to the SAMR model (Puentedura, 2006) of technology use, evidently engaged the students.



Video 22. Students at Hovell Public School engaging in transformative learning experiences

At Eyre Public School, some Year Six students also experimented with the use of an augmented reality app called String. As Figure 13 shows, the students used the app to create the illusion of a 3D character. While still in its infancy, augmented reality is likely to have greater educational value in the foreseeable future. This example also illuminates how the iPads provided unique opportunities for learning.



Figure 13. An example of work produced using the String app

It is important to note that not all tasks were at the transformative stage. At times, the demands of the syllabus for students to recall specific knowledge limited the ability of teachers to employ transformative tasks. For example, rote learning the spelling of high frequency words and recalling of multiplication facts is difficult to teach in a transformative fashion. However, in most of these instances, the teachers used the iPads and selected apps that significantly augmented the task.

Explicit instruction on copyright regulations needed

It was evident from an analysis of student work samples that there is a dire need for instruction about adhering to copyright regulations. Numerous digital images had been copied from websites without a creative commons licence without acknowledgments. During the site visits, the students were also observed searching Google Images for images they liked and copying and pasting them into their photo gallery to use in Keynote, Pages or other apps. This demonstrates sound technological skills but is in breach of copyright regulations. Students need to source and use copyright-free images and cite the source and creator of the image. This is an important 21st century skill. It is acknowledged that this is a particularly confusing topic for many teachers and there are misunderstandings about copyright regulations in the education sector. Teachers are encouraged to visit <http://www.smartcopying.edu.au/scw/go> for more details about copyright as it pertains to teaching and learning. This finding also points to the need for teacher professional learning in the area of copyright.

Pedagogy

Student-centred pedagogies supported with the iPad—students learn *with* not *from* the technology

Many teachers reported that their pedagogical approach had become more student-centred as a result of the iPad trial. This was also observed during the site visits. Teachers felt that the use of the iPad had encouraged them to shift some of the responsibility of learning to the students as it became easier for the students to document their learning. More importantly though, the iPads have

changed the way that my students interact with data. They are no longer expected to simply find and absorb information. Instead they are the ones who develop the meaning. When we are learning new concepts, more than just finding out the answers, the students are expected to explain the reasons why these answers are true in creative ways be it creating a movie, a slideshow, a voice recording or an animation' (teacher survey response). Another survey respondent stated, 'It has changed my teaching from teacher-directed to student-directed. The students now have a large input into how they would like the lesson run. There is a lot more talking and listening opportunities in my class now.'

In Video 23 two Year 6 students from Eyre Public School used the Show Me app to generate a video tutorial explaining how to convert centimetres into metres. Their class teacher, Ben, explained how the students would spend significant amounts of time rehearsing the videos to ensure the correct information was delivered. He felt that this repetition, in turn, improved their retention of the mathematical concepts far more than textbook based Mathematics lessons. This is indicative of some of the student-centred pedagogies that accompanied the iPad implementation and is also an example of a learning experience that would be challenging and expensive to reproduce using a desktop or laptop computer. Screen recording software is expensive and often difficult to use. However, the teachers reported that the students used several screen recording apps such as Show Me and Screen Chomp to easily record screen actions and verbal explanations. The design of such constructive apps no doubt supported student-centred pedagogies.



Video 23. Student video created using the Show Me app to explain a mathematical process

Synchronous use of a range of peripheral digital technologies

The teachers consistently identified that the iPad seamlessly integrated a range of technological tools including a still and movie camera and voice recorder. This is a chief affordance of the iPad as it removes the need for using different peripheral technologies that would ordinarily be needed if using a desktop or laptop computer. Instead of spending time downloading and importing images, video or audio, the iPad stores this information on the device and makes it easy for the user to access it. This affordance of the iPad is amplified in primary school settings where it is uncommon to have access to multiple digital cameras and video cameras. However, when using iPads the number of devices determines the number of cameras available. As Video 24 shows, at Hovell Public School one of the students used the Puppet Pals app to create an oral procedure explaining how to create food dragonflies.



Video 24. A student work sample of an oral procedure created using the Puppet Pals app

Figure 14 shows how another student used the Comic Strip app to create a written procedure. In both examples (Video 23 and Figure 14) the students made use of the built-in camera to take photos of each step and then used the photo to produce a professional looking piece of work. In the video the students also recorded their voices to annotate the images. These tasks would have involved a multitude of other steps had a desktop or laptop computer been used. Instead, the iPad allowed the students to easily create a multimedia product with an affordable app.

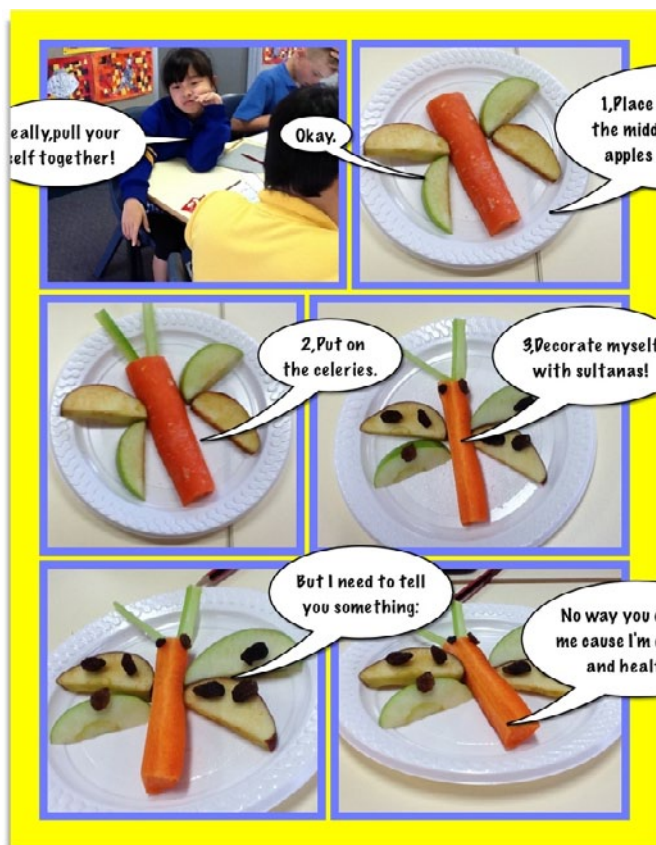


Figure 14. A student work sample of a written procedure using the Comic Strip app

Sharing work and just-in-time feedback

The teachers strongly believed that the iPad had enabled them to alter their pedagogical approach to provide more timely feedback to the students. They suggested that the students benefitted from more timely and frequent feedback on their work. For example, in Eric's class the students shared their work on the IWB

via the document camera allowing Eric and the other class members to critique a student's work which, in turn, allowed the student to easily correct and improve their work. This quicker turnaround time made the teacher's feedback more current and meaningful than the delayed feedback associated with traditional media. This is in stark contrast to the usual turnaround time associated with collecting and marking work completed in a book. Harmen (2010) also found that the provision of feedback accounted for improved student learning when using an iPad.

Informal assessment practices supported

The teachers indicated that they used the iPads to provide informal and ongoing assessment data. The teachers explained that they collected digital work samples as evidence of student learning. One survey respondent stated, 'The content they (students) have created can be formatively and summatively assessed throughout'. They reported that it was easy to provide ongoing feedback to the students because they could view their work on screen and provide suggestions for improvement during the lesson. Alternatively, as there was an increase in students sharing their work, usually with the IWB, the students were also providing feedback for improvement. The teachers also stated that it was easy to collect and mark student work in a digital format as students could email their work to the teacher. This nullified the need for the teacher to take books home to mark.

Need for teachers to have a thorough understanding of technology, curriculum and pedagogy prior to implementation to ensure the devices are used to their potential

The affordances attributed to the iPads can only be actualised if teachers have a sound understanding of technology, curriculum and pedagogy. Through the intersection of these factors the optimal use of the iPads can be actualised. All of the principals involved in the trial exemplified how critical it was for teachers to have sound pedagogical practice and knowledge of the curriculum before using iPads. They acknowledged that while the iPad was a powerful learning tool, it was only as good as the teacher who was designing learning experiences for its use. The teachers had to be familiar with the curriculum requirements and then design relevant learning experiences using apps where appropriate. Once again, this elucidates the critical role the teacher plays when using iPads. Interestingly, all of the principals interviewed agreed that because the iPads were very intuitive devices and simple to use they did not consider poor technological skills to be a barrier to their use. In fact, Steve suggested that his school was considering using the iPads with teachers who had identified that they had limited technological skills. As a device that is easy to use, it is likely that the iPad will not be approached with trepidation.

When using any form of technology there are dynamic, complex and transactional relationships between content, technology, pedagogy, and context. In the trial, the participating teachers showed high levels of awareness of how technology, pedagogy, and content knowledge (TPACK) intersected. Koehler (2011) developed the TPACK model to highlight that teachers required multifaceted knowledge in order to ensure effective integration of technology. The TPACK model is summarised in Figure 15. It advances Shulman's (1986) model of 'Pedagogical Content Knowledge'. Technological Content Knowledge (TCK) is knowledge of the relationship between technology and content. At the intersection of T and P, is Technological Pedagogical Knowledge (TPK) which emphasizes the existence, components and capabilities of various technologies as they are used in the settings of teaching and learning. Finally, at the intersection of all

three elements is Technological Pedagogical Content Knowledge (TPACK). True technology integration is understanding and negotiating the relationships between these three components of knowledge. A teacher capable of negotiating these relationships represents a form of expertise which is different from subject matter experts or pedagogy specialists. Effective technology integration for pedagogy around specific subject matter requires the development of sensitivity to the dynamic and transactional relationship between all three components. The teachers involved in the trial were able to show awareness of the interrelationship between pedagogy, content and technology.

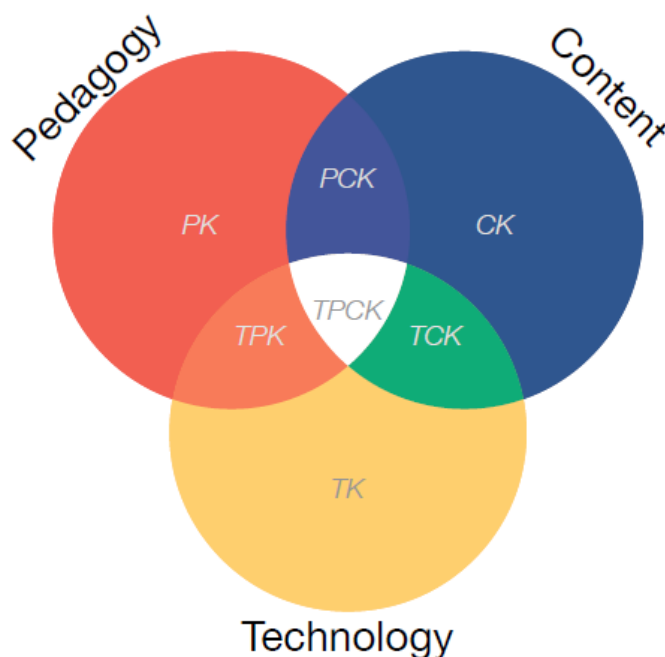


Figure 15. Koehler's (2011) TPACK model of technological integration

Multimodal nature of the device afforded new opportunities for learning

Many teachers identified new opportunities for learning with the iPad because of the multimedia products that the students could easily produce with the device. The increased pace of learning and new opportunities for creative expression were two affordances. The teachers reported that the pace of lessons had increased during the iPad trial. As the device supplemented the students' current skill level and made tasks such as handwriting quicker a faster pace of learning resulted. This often meant that the teachers were able to cover the same curriculum requirements in a shorter time. One survey respondent stated, '(the iPad) allowed for more creative and multiple choices for expression. Much faster paced than traditional methods for a much higher standard of work therefore needing to extend and expand tasks and expectations'. Teachers also noted that creativity was fostered with an iPad, as reverberated in Video 25. One survey respondent stated, 'My lessons are a lot more creative with an iPad. The students can easily produce creative work'.



Video 25. Creativity was supported with the use of an iPad

For example, students can easily create a poster using the Strip Design app or generate a mind map to demonstrate their understanding of a topic. Amanda described how the students used the built-in camera to take photos on an excursion and then used these when they returned to class to create a multimedia recount about the excursion. Video 26 provides an example.



Video 26. Students used the Puppet Pals app to create a multimedia recount of an excursion

Technology can complement traditional hands-on activities but should not supplant them

Melanie was emphatic that the iPads should not replace learning experiences with concrete materials. In particular, she highlighted the importance of students manipulating objects particularly in the Creative Arts curriculum area. In her class, the students took digital photographs with the built-in camera in the iPad while on an excursion at the Botanic Gardens. When they returned to school the students used the photos they had taken with the PS Express app to manipulate digital photographs (as shown in Figure 16). The students then used crayons and other tangible media to create a 'traditional' artwork (as shown in Figure 17).



Figure 16. A student work sample of a flower using the PS Express app



Figure 17. A student work sample of a flower, created after taking digital photographs during an excursion

iPad 's use to support a teacher's administrative tasks

Anecdotally, many of the teachers reported that the iPad was a helpful tool to fulfil some of their administrative tasks. Ben explained how he used the Evernote app to record information from professional learning courses and also to take notes during meetings, 'It has allowed me to organise my teaching world a lot more. I have really enjoyed using Evernote...whether it's on my computer or on my iPad they synchronise, so I don't need to be looking for paper or carrying a diary, it's all in one spot'. Ben also explained how it was easy to locate students' missing passwords on the iPad without having to disrupt a lesson to go to his computer to look up a password.

Intuitive and easy-to-use tool with minimal technical help required

The students and teachers both explained how the iPad was an easy tool to use and navigate. There were few technical issues that could not be resolved by turning off the device and re-starting, according to Amanda. Ben stated, 'iPads... they are so intuitive, even for teachers who don't use technology'. This ease of use of the iPad enabled teachers to explore more innovative pedagogies when using the device. Too often, teachers attempt to use technology in creative and student-centred ways but technical difficulties and barriers hamper their efforts and they

are, in turn, often reluctant to use technology. As an intuitive device, the iPad encouraged teachers to explore more student-centred and engaging approaches because they were confident that the iPad would function as intended.

Parent Concerns and Needs

A total of 11 parents completed the online survey via Survey Monkey and one parent was interviewed. While it is acknowledged that this is a limited data set, analysis of these data sources revealed some consistent findings.

Most parents reported that they were happy for their children to use mobile devices sighting educational advantages as a prime reason to justify their shared use. Parents preferred that their child was pursuing educational activities on the mobile device, instead of 'just playing games,' as they did not associate gaming with learning. Parents felt that the drill-and-practice (instructive) apps were ideal for their children to use. It was reported that apps that taught Mathematics and English concepts such as letters and sounds were appealing to parents. No parents in the survey mentioned that their child used any creative or constructive apps. When selecting apps for their children to use on their mobile device, 62.5% of parents searched in the Education or Apps for Kids sections of the iTunes store. In addition to perusing the iTunes App Store parents also considered recommendations from friends or relatives and apps advertised or recommended in popular media such as television advertisements, magazines or newspapers. It appears that parents are seeking information about apps suitable for children to use on mobile devices.

Most parents stated a preference for their children using educational apps on a mobile device but most admitted that their children played non-educational games on the mobile devices they accessed at home, as shown in Figure 18. This confirms previous research from large scale American studies that found games are the most popular type of app downloaded on smart devices used by children with an average of 10 game-related apps on each device a child uses (The NPD Group, 2010). Overwhelmingly, the subject area of Mathematics was identified as the subject area for which parents sought educational apps. This may be because it is a subject area that parents often feel poorly equipped to teach their child.

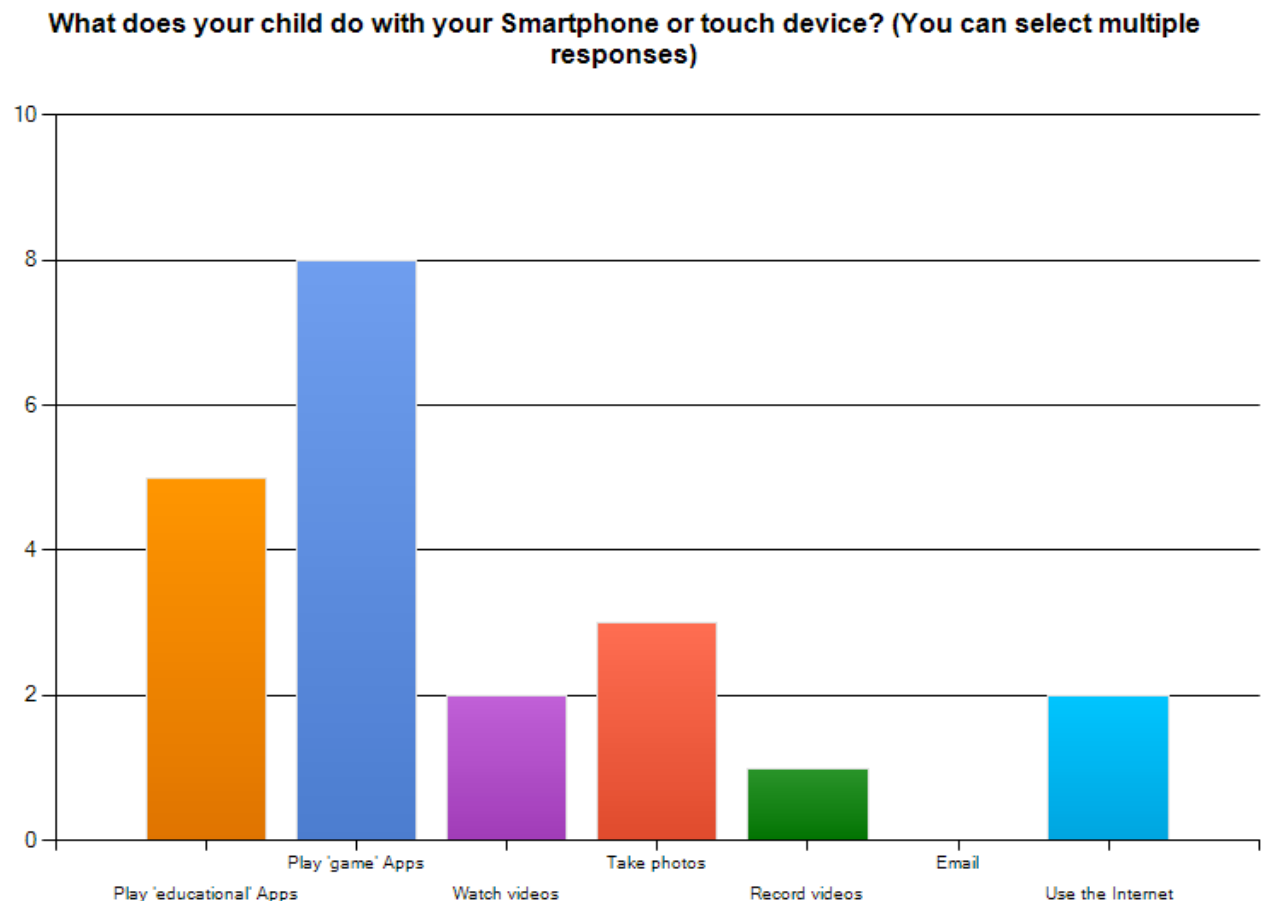


Figure 18. A summary of the types of activities students engage in at home with a Smartphone or touch device

Parents' concerns related to children's safety when using iPads and other mobile devices. They expressed concerns about their impact on children's learning and development. Online safety was identified as a concerning area for parents: of the parents surveyed, 72.7% did not know how to set parental controls on their mobile device to manage and restrict their child's access to inappropriate online content.

Most of the parents were familiar with the recommendations regarding screen time and 81.8% of survey respondents indicated that their child adhered to the current recommendations of one to two hours of screen time per day.

The findings from the parent data were used to compile a Parent Information Sheet about Mobile/Touch Devices which can be found in the Appendices.

Technical and Logistical Considerations

There are some important considerations for schools to address before purchasing iPads. iPads are designed as single user consumer devices, not for a shared environment such as a school. 'When you get frustrated with how the iPads work in a shared environment, remember that you are shoe horn[ing] a device that's designed for a single user into a shared classroom setup' (Hasic, 2011, p. 8).

Note: at the time of publication of this Evaluation, iPads are not a supported product in the NSW DEC system. This has significant ramifications for schools that require technical support with iPads as the onus is on school personnel to facilitate this support.

This section is divided into four major sections as outlined in Figure 19.

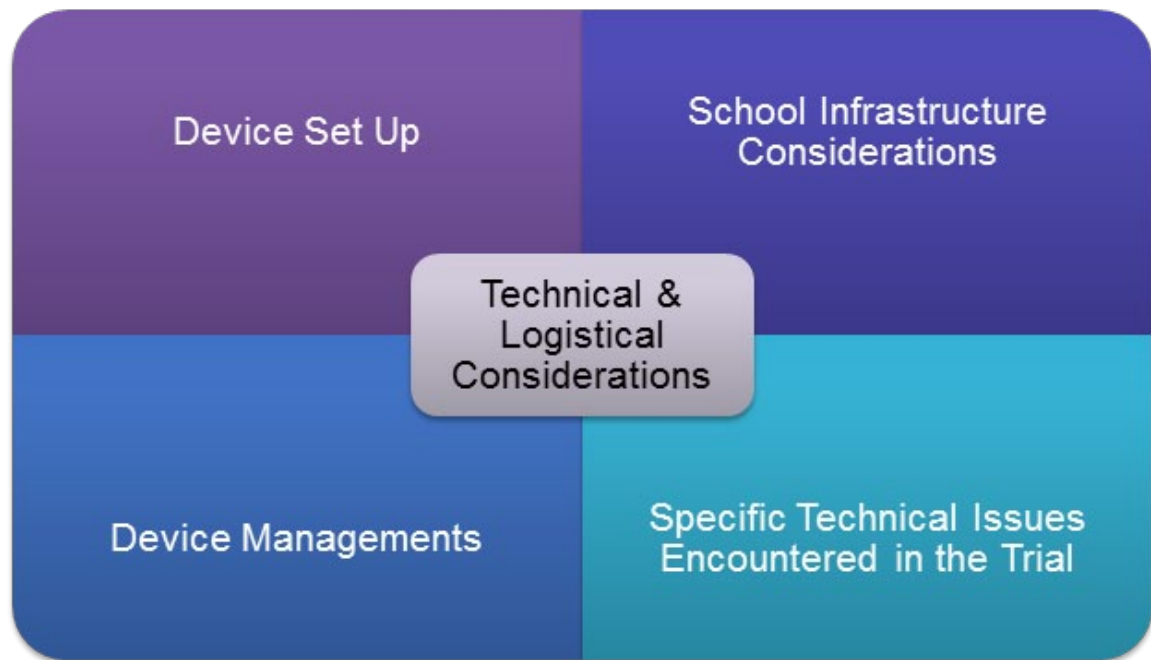


Figure 19. An overview of the 'Technical and Logistical Considerations' section

Device Set Up

iPads required a lot of time for initial set up

The initial set up of the iPads was a time consuming process despite the teachers being provided with detailed training and information. All teachers and principals involved in the trial noted the significant time required to set up the iPads and find solutions to the technical problems they faced at this initial stage. The teachers also noted the high level of support they received from the Technical Support officers from Sydney Region and also from Apple staff who helped suggest solutions to some technical difficulties. One teacher cautioned, 'Don't just buy them and expect them to happen.'

Each teacher needed to create an iTunes account for each iPad and then synch each device to the corresponding iTunes account. Establishing an iTunes account required an email address. In turn, the teachers had to create original Gmail accounts that corresponded to each iPad. This also proved to be difficult as most free email services make it very difficult to create multiple accounts from the same computer in an effort to thwart spammers. The funding for the trial included a \$50 iTunes card for each iPad but it was the responsibility of each school to purchase and activate the iTunes card for each device. This proved to be troublesome because many retail stores selling iTunes cards are not equipped to simultaneously transact multiple iTunes purchases, as Video 27 below exemplifies.



Video 27. Steve, a Principal, explains some of the technical difficulties they encountered whilst setting up the devices

Teacher professional learning

All teachers who participated in the trial agreed that minimal professional learning was required on how to operate the iPad because it was such an intuitive device. They did, however, acknowledge that some professional learning and support is required to set up and manage the device. It was proposed that the focus of professional learning should be on how to select and locate educational apps and time to explore the apps and consider more transformational pedagogies that can be used with iPads. Ben explained, 'We need to transform learning tasks that promote high intellectual quality. No need for formal instruction on how to use iPads as they are so intuitive even for teachers who don't use technology'. The teachers all reported that they found the Apple Sandpit training day beneficial as the focus was on selecting and exploring educational apps. Teachers also believed that informal professional learning opportunities were required for future learning. Eric suggested teachers create personal learning networks (PLNs) as he believed these were an ideal way to stay informed about iPads and app updates. The reciprocal nature of PLNs provides an ideal way to keep up-to-date with apps. Melanie reported that professional development opportunities needed to include video footage of students using iPads in classrooms in various ways as a catalyst for innovative ideas on their implementation. All teachers reported that they also found emails and blogs helpful sources of information for selecting educational apps. Three of the teachers mentioned that they had used DEC's Maang microblog to find current information on iPads and apps. Amanda proposed that videos of iPads being utilised in classroom settings would be helpful to provide real examples of iPad deployment in classroom settings.

App licensing and deployment

There is a common misconception amongst schools that apps can be downloaded via a single iTunes account and synced to multiple Apple devices (iPod Touch, iPad). Another misunderstanding is that an app can be legally purchased and synced to 5 devices. The App Store Terms and Conditions clearly specify that, 'If you are a commercial enterprise or educational institution, you may download and sync an App Store Product for use by either (a) a single individual on one or more iOS Devices used by that individual that you own or control or (b) multiple individuals, on a single shared iOS Device you own or control... For the sake of clarity, each iOS Device used serially by multiple users requires a separate license' (Apple, 2011). In a school setting it is imperative that a unique Apple iTunes account is established for each iPad and each app must be purchased for each iPad/iTunes account. This has implications for how apps are purchased and synced. Further information about licensing apps is available at <http://www.apple.com/legal/itunes/au/terms.html>.

In order to purchase apps, each iPad required an iTunes account which required an email address. In a class setting where there are 30 iPads, 30 different iTunes accounts must be established and 30 different email addresses are required. Generating 30 different email addresses can sometimes be problematic even using GMail accounts. Other viable alternatives may be YahooMail or Hotmail accounts.

Once the iTunes accounts are established, either a credit card number against each iTunes account must be registered or separate iTunes Gift Cards need to be purchased in order to download paid apps. The latter method is preferred but purchasing multiple Gift Cards can prove difficult as some popular retail stores do not have the infrastructure to allow multiple gift cards to be purchased simultaneously. Video 26 details some of these issues. For further information about establishing iTunes accounts without credit card details is available from <http://www.support.apple.com/kb/ht2534>.

Installing apps on iPads

There were various methods for installing apps used throughout the trial period. All teachers acknowledged that this was a time consuming process, as each app had to be installed on each device. Most teachers reported that they took the nominated computer and students' iPads home to install apps. Melanie initially took the iPads home to install apps but soon realised that her students could install the apps and learn important technical skills along the way. She listed the names of the required apps on a board and had the students access the iTunes App Store on their device and download the app themselves. She then had to enter the password on each device. While this was more time efficient for Melanie, she reported that she felt it was inefficient use of students' learning time. It is hoped that more centralised and simple solutions will soon be available to allow for the quick installation of apps on multiple devices.

With iOS5, it is possible to connect wirelessly via the NSW DEC network infrastructure directly with each iPad to the App Store and make necessary purchases using each iTunes account. No syncing is required and App updates can be applied directly on the device. However, it is strongly recommended that the iTunes account password is not shared with students. This nullifies the need for syncing each device with a computer, as the downloaded apps are saved in the iTunes account 'Purchased' section. There have also been suggestions that the App Store Volume Purchase Program, which has been rolled out in America, will soon be available in Australia. This will allow educational institutions to purchase iOS apps in volume and distribute them to their students accordingly.

School Infrastructure Considerations

Wireless access

Before schools purchase iPads they need to consider the adequacy of their wireless network as this has major implications for the mobility of the devices. A limited wireless network constrains students' ability to use the device anywhere, anytime. DEC Schools are provided with Internet access via an Authenticated Proxy and filtered service. Two wireless access points are recommended for NSW DEC schools: (i) HP Procurve MSM 410 with Power Injector is recommended for portable situations where the access point moves with the iPads; and (ii) Aruba IAP-105 is recommended for fixed situations where wireless access is needed across a wider number of rooms. Schools are advised to ask for help before

purchasing a wireless access point, as simply plugging one into your school's network without correct configuration can cause technical problems (Hasic, 2011, p. 24).

iPads used in conjunction with Interactive Whiteboard

Many NSW DEC schools have installed IWBs and would like to connect peripheral devices such as iPads to the IWB. Teachers involved in the current trial used two methods to connect: (i) a VGA adapter was used to connect the data projector to an iPad to share students' work or demonstrate how to perform a task; and (ii) a document camera was connected to a data projector and students would place their iPad underneath the camera and display their screen and any interaction with the device on the IWB or screen. This also allowed the students or teacher to demonstrate how to navigate the app or share special features within an app whereas this is not possible when using a VGA adapter which only shows the results of the interaction.

Internet settings on the iPad

In NSW DEC, Internet access is only provided via an authenticated proxy service which means that in order to access the Internet, all users must provide authentication in the form of unique usernames and passwords for each student or staff member. On the iPad, this means that the address of the proxy server needs to be entered against the wireless connection and the authentication option turned on. Unless this is done, Internet access is not possible. Student authentications get a more stringently filtered Internet than staff authentications. For example, teachers can normally access YouTube, Facebook or Twitter but students cannot. NSW DEC employs different filter sets for each scholastic year group on a state-wide basis meaning that infant students are filtered more than primary students, who in turn are filtered more than high school students.

Device Management

Naming conventions and labeling of iPads

Each iPad involved in the trial had a number assigned to it. Stick on labels were used on the back of each device to label from SRiPad01 through to SRiPad75. This allows students to quickly identify their iPad in the event that the coloured case is removed and it also allows administrators to manage the allocation and collection of devices.

iPad storage and charging

All schools reported that storage was relatively easy with all devices being locked in storage cupboards attached to the class. None of the trial schools used a commercial syncing station. Instead, the devices were charged in a locked space and synced to a designated computer or laptop with separate iTunes accounts installed on each device. At one school, a tiered bookshelf was used which successfully allowed students to quickly access their own device and facilitated easy charging.

Teachers involved in the trial study reported that, compared to laptops, the devices required minimal charging. Contingent upon student usage, most teachers reported that they could use the device for two full school days before charging was required. Overnight charging was sufficient. To prolong the in-built battery life, users are advised to only charge the iPad when necessary: they are encouraged to wait until the indicator is below 10% before charging. Even at 10% an hour of use is usually possible. Users are also advised to fully charge the

device. Given that this took several hours, most schools decided to charge the devices overnight while they were securely stored. The teachers noted that the students were very responsible when using the iPads and always ensured they had adequate battery life.

Deletion of apps and data

It is important to consider how students will maintain any data on an iPad if a one-to-two or one-to-many ratio is implemented in a school setting. With iOS4 it was possible for a student to delete all apps and corresponding data and recovery was only possible from when the device was previously synced to its host iTunes Library. In iOS5 a restriction setting can be applied to make it significantly more difficult to delete apps. Again, this is why it is crucial that iPads are frequently synced to their host iTunes account.

Security of Teacher Accounts

One issue that has been noted is that while the iPad does initially ask the user for their username and password to access the Internet in an authenticated proxy environment, it often remembers that username and password for future internet sessions. While this is very convenient for the user, in a shared environment where multiple students use each iPad, the initial student's authentication is applied to all. If that initial user was a teacher, then subsequent students who use the iPad could get access sites that they normally could not.

App installation on students devices with teacher approval

Most teachers reported that they selected the apps to install on the iPads. However, several teachers also noted that some students identified apps that they would like to use. The students would provide the teacher with the name of the app for review, and if deemed suitable, the app would be installed on the student's device. The teachers noted that they needed to approve every app that was installed on each device.

Ongoing maintenance

In an effort to prolong the life of iPads, thin film-screen protectors and covers need to be purchased for each device. These additional costs should be factored in when budgeting for iPad acquisition.

Updates for apps are frequently released. This pilot study revealed that the easiest way to update apps is from the App Store on each device. However, in order to do so, the Apple iTunes account details are needed so this task needs to be performed by the teacher as passwords are required.

It is imperative to intermittently sync each device to its host iTunes library to back up the apps and copy data within each app. This will allow for easy data recovery if necessary. It is essential that this is done before updating the iOS. At the time of publishing this Evaluation, iOS5 update was available and existing iPad users were strongly encouraged to install this update. However, it is a time consuming process, as many teachers in the trial discovered, as it normally takes approximately 30 minutes to update each device (800MB download for each iPad). The Technology Advisors from the Sydney Region devised a quicker way to disseminate the update which involved a single download of the iOS5.01 update and placing it into a folder on the computer that hosts the iTunes Libraries.

Technically, a syncing station can be used to make all iPads the same as long as all apps have been legally bought against separate iTunes accounts. However, there is a need to be aware that all iPads will have the same name and all will have user data wiped every time they are re-synced. In addition, an Apple computer is required to simultaneously sync multiple iPads.

Specific technical Issues encountered in the trial

Restricted Internet access via the DEC portal

Teachers reported that they experienced some ongoing technical issues throughout the trial period but did not believe these compromised their teaching nor deterred them from using the devices. The most common problem related to apps which required Internet connectivity. Eric explained how the Drop Box app could not initially be used on the iPads running iOS4 because the apps could not authenticate to the proxy server. Melanie also explained the frustration in downloading and evaluating apps at home and then not being able to use them at school because they required authentication with the server. This was problem was restricted to apps requiring Internet connectivity and rectified with the installation of iOS5.

Technical issues within apps deterred students from future use

The students were not as tolerant as teachers of technical difficulties with apps. During the site visits and student interviews, students explained how they would stop using an app and search for a suitable alternative if an app did not work properly or had technical issues. This is yet another indication that today's students seek instant gratification and it also demonstrates how the students saw the iPad as a tool to meet their learning needs. This resolution to technical problems is vastly different to those reached with laptops and desktop computers: when software does not work the task is usually ended until a solution is reached. Typically one program is installed to perform a task. However, with the iPads, there was a wealth of apps that could be deployed to perform a similar task. This is vastly different to computer contexts where there is typically one program.

Students quickly identified their device through coloured covers and numbered iPads

Coloured protective covers allowed the students to identify their device quickly and efficiently, according to the students and teachers involved in the study.

Students required to recall a multitude of passwords

Several students noted that there were many passwords they were required to recall when using the iPads. Although this is not a problem unique to the iPads, as many websites require a password, it appeared that many of the web-based apps that were in use required a password. Teachers need to be aware of these demands, especially for younger students.

Sharing and saving work

The iPad is often criticised for its lack of a transparent underlying file system and difficulties experienced transferring files from the device to a computer and vice versa (Marmarelli & Ringle, 2011). In the trial, teachers shared students' work on the projector or on a screen using a data projector (where an IWB was not installed). The iPads were connected to the IWB, as described in the section 'Wireless access'.

Another alternative where the app permits was to email finished work but this requires an outgoing email account to be established on the iPad. Printing work is possible from an iPad but is difficult to do at this stage. Dedicated hardware such as special printers or specific software installed on computers is required to print work. Interestingly, none of the teachers involved in the trial saw the need for printing: they were pleased to use a digital product and either share this with the class, have students email it to the teacher and/or upload a digital copy to a shared space such as a class wiki (Wikispaces or Posterous sites were used by teachers in the trial). However, the onus was on the teacher to upload students' work which places additional demands on their time.

Coverage of wireless network can limit the mobility of the devices

Several teachers reported that they had limited device mobility because of the limited range of the wireless network within the school. This inhibited some Scavenger Hunt activities that had been suggested at one of the training days and also impacted on the desire by some teachers to use the devices throughout the school. One teacher mentioned that they would like to use the devices outdoors to showcase a particular skill during physical education lessons but were unable to do this because their wireless access was insufficient. This demonstrates the importance of understanding the limitations of a single wireless access point and the issues associated with introducing multiple wireless access points in a school. It is essential to obtain technical advice and guidance.

Recommendations

Future Research

Given the brief trial period and relatively small sample size, further studies of iPads and/or other mobile devices are justified. It may be worthwhile exploring how these devices can be utilised by teachers with limited technological skills. Many of the teachers and students reported that the iPad was an intuitive and easy device to use. This may provide the impetus for teachers with limited technology experience to explore how to integrate technology into learning experiences. Given that the teachers involved in the trial had displayed superior technological skills and knowledge, it is highly likely that different findings may have resulted had an alternative sample of teachers been recruited.

As the results do not provide a comprehensive measure of the extent to which learning outcomes vary with respect to iPad use, further studies that include natural observation, surveys and student focus groups are recommended. Comparative, quantitative data is also required to confirm the impact of iPads on student achievement. The use of empirical studies may be warranted to determine the educational impact of iPads on student learning outcomes. However, as this study has illuminated, it is not so much the device that impacts learning but the fashion in which it is used by the teacher. Therefore, any quantitative studies undertaken must not omit the role of the teacher.

Further research that explores how students respond to various apps is merited. Scientific knowledge is required about how students approach, learn and play with different app designs. Specific research needs to critically examine the design components that comprise an app's anatomy. In the current study a variety of different types of apps were used, from instructive drill-and-practice apps to manipulable apps and constructive content-creation apps. Each of the different app designs elicits varying cognitive demands of the learner, for example, high order thinking skills are often required when using constructive content-creation apps. Further studies investigating the different design principles of educational apps may be warranted. This would not only inform app developers about the principles of effective app design and the salient features they need to include in an app designed for young students, but would also provide teachers with insights into how students use different apps in different ways.

Additional research may also be necessary to consider how iPads can be used to support learning in various KLAS. In the current trial, several teachers suggested that while they used the iPads in most subject areas, Mathematics and Personal Development, Health and Physical Education (PDHPE) KLAS were challenging disciplines in which to use the devices. This may be attributed to the design of apps currently available but it was beyond the scope of the current study to investigate the reasons for this finding.

Given that 20% (n=17) of the students surveyed claim that they have access to an iPad at home, there is an urgent need for current, evidence-based information to be provided to parents about the best use of such devices. It is likely that an even greater proportion of students have access to other mobile devices such as smartphones and tablet devices. As there was only a small response rate for the online parent survey, further research needs to examine how students are using mobile and/or touch devices at home. This could provide information on whether the devices are used in a manner that is commensurate with how they are used at school. From the limited data obtained from parents in the current

trial, it is apparent that parents require information on how to ensure their children are safe when using mobile devices, how to access and determine the quality of educational apps and information about the benefits of using such devices.

An external evaluator, the author of this evaluation, was appointed in December 2011 as the trial concluded. In some respects, this late appointment limited the types and scope of data that could be collected to evaluate the trial. It compromised, to some extent, the nature and volume of data that could be collected to evaluate the trial. Future trials should seek to appoint an evaluator, where necessary, at the inception of the project. This would enable a broader data set to be obtained and may also provide opportunities for longitudinal and/or pre and post intervention data to be collected, if this was within the scope of the trial.

Teachers

The chief finding from this trial relates to the critical role of teachers. There are often concerns that advancements in educational media will make teachers redundant. As this trial has illuminated, the converse situation holds true—regardless of its technological innovation, the ultimate success (or failure) of the device in classrooms rests with how it is deployed by teachers. The pedagogical framework in which the teacher situates the technology determines its success and impact on student learning. Therefore, any professional learning related to the use of technology integration needs to focus on the teacher's role and not solely focus on the technology. The teacher is central in any technological innovation and not the technology.

To ensure that iPads and other mobile devices are used in an optimal way, teachers must be willing to adopt a student-centred approach. They must allow the students to determine how the device can be best used to suit the needs of their learners and also the curriculum requirements. The iPad, and other mobile devices, offer students unique opportunities for learning to be personalised and meaningful. However, this can only occur in classrooms where a student-centred philosophy is embraced. For some teachers this will require a radical shift in their philosophy.

This trial has also shown that teachers must not only have a sound knowledge of the best pedagogical approaches to use, but they must also have a strong understanding of the curriculum and its requirements when implementing any technology. To ensure that iPads, or any other mobile devices can be used in an optimal way teachers need to be adept at matching the syllabus requirements with the most effective pedagogies and then considering how technology can be interlaced with both of these elements.

Given that students are exposed to vast amounts of digital information and images, today's students need to develop critical literacy and visual literacy skills. This reverberates with the recommendations from Green and Hannon's study (2006) where it was also suggested that teachers develop students' media literacy skills. Teachers need to ensure that students develop important skills and understandings related to the use of digital media. Research strongly suggests that media education may result in young people becoming less vulnerable to negative aspects of media exposure (American Academy of Pediatrics, 1999). Teachers need to explicitly teach how to access and evaluate digital information with a particular focus on discerning information from graphics.

The development of an app selection rubric and database of educational apps is also recommended to support teachers' use of iPads and other tablet devices. An app selection rubric would provide teachers with a prescriptive framework to guide their decisions about critiquing and purchasing apps. This may help

to reduce the time teachers spend evaluating the educational effectiveness of apps and allow them to make informed purchasing decisions. A similar recommendation pertains to the establishment of a database that details educational apps and their relevance to the curriculum and intended age range for users. While it is acknowledged that there are numerous websites and blogs maintained by teachers throughout the world listing educational apps, there are few that have an Australian focus (see the Appendix: Suggested Websites for Teachers Using iPads) and even less that are created by NSW teachers. It is recommended that this list be published and expanded in order to support DEC teachers using iPads. However, for long term use the development of a digital database where a list of apps can be regularly updated online is recommended. The design of the Blooming iPads page is noteworthy (see <http://kathyschrock.net/ipadblooms/>) as is APPitic site (<http://appitic.com>) It would also be advantageous for teachers to comment on the apps, explain how they used them and perhaps share student work samples. This would also be an authentic professional learning experience for teachers.

Teachers need to think carefully about systems for file management given the increased volume in students' digital work. In the current trial, students emailed work to teachers, resulting in an increase in mail in the teachers' email accounts and additional demands on a teacher's time to upload this work to an online space. This decision may be more of the responsibility of administrators, rather than teachers. However, cloud-based services provide new prospects for mobile devices. Online storage solutions such as Dropbox or iCloud should be considered as possible solutions to file transfer issues. A central place for sharing student work is also required, whether it be through a wiki or other collaborative platform. DEC administrators need to consider alternative ways for students and teachers to share their digital work via secure online platforms which would also allow parents and guardians the opportunity to share student work. At present, teachers in the trial needed to establish their own methods for sharing digital work with their parents, via the establishment of a wiki or Posterous site.

Teachers should consider seeking educational material in iTunes U rather than relying solely on the iTunes App Store. There is a plethora of digital resources available in the iTunes U section of the iTunes store. These would work seamlessly on an iPad and provide additional educational materials to complement what teachers are currently doing with iPads.

At the time of publication of this evaluation, Apple released details of a textbook distribution model. On 19 January 2012 Apple released an iTunes U app that enables users to access a digital catalogue of free educational content including university courses and resources from other schools. This app allows teachers to combine audio, video and iBooks into courses. They can create a complete syllabus and even assignments. In addition, Apple also released iBooks2 and iBooks Author. These new releases are believed to have a big impact on the educational use of iPads and require further investigation as further details become available. Some preliminary details are available on <http://www.apple.com/education/>.

Teachers could also consider using the AirPlay function that is part of the iOS5 update. This may be suitable for sharing student work throughout a lesson not only for sharing work during the plenary session at the conclusion of a lesson where iPads are plugged into the VGA connector or displayed on the IWB using a document camera. This would allow teachers and students greater access to information in a more timely fashion. For example, AirPlay could be used to display videos and any other digital content on an iPad through video mirroring. Teachers and students can wirelessly and securely stream whatever is displayed

on their iPad 2 to a High Definition television via Apple TV. This may be more cost-effective than an IWB, provide greater flexibility and student ownership of learning and enable more ongoing feedback to be provided.

App Developers

As revealed in the current trial, both teachers and students prefer content-creation apps. There is a continued need for content-creation (constructive) apps that are easy for students to use. Teachers and students want apps that enable them to easily create multimedia products in the form of animations, videos, comic strips, posters and podcasts. It is acknowledged, however, that the design of such open-ended apps is often more time consuming and costly for developers. It may be worth considering if some apps could be designed, piloted and built in-house in CLIC to meet the specific needs of students and teachers.

iPad developers need to ensure that their apps are intuitive and simple to navigate. The students in this trial rarely used the video provision and print tutorials within apps. They showed a low tolerance for complicated apps and were quick to disengage from an app if its functionality was not intuitive. Students were also reluctant to persevere with an app if there were technical issues and would not use the tutorials or help videos. Therefore, the onus is on app developers to devise products that are simple to use.

The ability to export finished products in content-creation apps is also essential in the DEC context. The teachers in the trial found that some apps did not allow for export options which limited the audience of the finished work. Apps need to provide the capacity to email or export finished work to a cloud storage service. Integration with web platforms or wikis or cloud-based storage sites (such as Drop Box) would also make sharing student work easier. In the trial, students emailed the teacher any finished work (where this was possible) and then the teacher would have to upload the work to a class wiki. This placed extra demands on the teachers and became a teacher driven task. Late in the trial, Ben discovered that the students could upload their work to the Posterous website. It would be interesting to determine if developers could allow for apps to be integrated with such sites.

As this study suggested, it may be worthwhile for app developers to consider the importance of providing instant feedback, quantifiable scores, capacity to select levels, and reward systems when designing instructive games-based apps. These characteristics were identified by both the students and teachers involved in the iPad trial as appealing design features in the instructive apps. Obviously the intended age of the user determines the nature of these features. Again, it may be feasible to consider in-house development of some educational apps.

Future educational app designs need to be based on good pedagogical and usability principles. The design features inherent in many games-based apps are based on out dated, redundant theories of learning which view students as passive recipients of pre-determined content. It can be inferred from the design of many apps that designers' assumptions about education (and especially about a new educational technology device such as the iPad) are based on a behaviourist approach. This has resulted in the creation of poorly designed learning products that don't enhance students' learning. It appears that many of the game apps are a replication of the design of drill-and-practice computer software that dominates the educational market.

There is also a need for app developers to devise apps that capitalise on the unique features of an iPad such as multi-touch gestures, screen sweep function and gestural responses. There were few apps used in the trial period that took

advantage of these capacities. The iPad, and other mobile devices present unique opportunities for developing more interactive apps that maximise the potential for embodied learning as outlined in the Literature Review.

There is a dire need for Mathematics apps that go beyond the drill-and-practice and games-based paradigms. In the current trial, both parents and teachers sought quality apps to support Mathematics learning. The iPad offers unique opportunities for presenting dynamic representations onscreen. This is particularly helpful in Mathematics and Science KLA's where there are many abstract concepts. The visual and interactive elements of touch devices, such as the iPad, may allow learners to develop more robust conceptual understandings of concepts that are difficult to master.

Standards of evidence are also needed to enable apps to be classified as educational apps, as many apps submitted under this category lack an educational focus. At present the criteria required for an app to be included in the iTunes App Store Education section is unclear. It appears that apps are included at the developer's discretion.

Implications

Implications for teaching and learning

Teachers and school decision makers need to think carefully about the technical and logistical implications of using iPads in the classroom before purchasing the devices. Designed primarily as a single consumer device, there are practical and technical implications for deploying the devices in a school environment. As this trial highlighted, the paramount factors that need to be considered are: wireless access and infrastructure required; establishment and maintenance of iTunes accounts for each device; and methods of exporting and sharing student work.

A key finding from this trial relates to the critical role of the teacher in ensuring that the potential benefits of the iPad are actualised in a classroom setting. Despite the trial focusing on the iPad and its affordances, this trial has made it clear that the teacher and the pedagogical approaches and tasks they implement are critical to the success of the device. The affordances of the iPad are mediated by the teacher's philosophical beliefs about learning and the subsequent pedagogical approaches they implement with the iPad. Regardless of the many attributes of a mobile learning device such as an iPad, unless accompanied by sound pedagogical practice its potential benefits may not be realised. Teachers need to spend time considering how to implement the iPad in their learning environment and class context to yield maximum results. The iPad must be embedded into authentic and student-centred tasks that allow the students to utilise many of the iPads features. This again provides fertile evidence that technology alone cannot make a difference to student learning: the teacher is fundamental in this process.

This trial has also illuminated the need for students to develop media literacy skills. Critical and visual literacy skills are important skills of the 21st century. There is a dire need for explicit instruction on critical and visual literacy skills as students using iPads in conjunction with other screen devices are subject to a preponderance of visual images. They need to develop critical skills to enable them to discern any incorrect information and process graphics with ease. This is not only essential for using touch devices, but any form of screen-based technology as emerging research indicates that today's learners process graphics before text and have a preference for learning with images (Prensky, 2001b).

Implications for future professional learning

Future professional learning should be based on the TPACK model to ensure that teachers are aware of the interplay between technology, pedagogy and curriculum knowledge (Archambault, 2008). The TPACK framework is an ideal way to think about effective technology integration as it focuses on more than developing teachers' technical proficiency. This trial has elucidated the symbiotic relationship between these elements. Further details about the TPACK model are included in the Literature Review.

As the teachers involved in this trial have suggested, non-traditional professional learning models may also need to be considered for mobile device training. Asynchronous forms of communication, whether this be through blogs, wikis, emails were suggested as possible platforms for future professional learning. The development of PLNs was also proposed as a viable learning model where teachers assume responsibility for seeking learning opportunities based on their needs. In relation to establishing a PLN, teachers are encouraged to use Maang, a microblogging site for DEC staff members to keep up-to-date with new apps

and educational use of iPads. Also, the use of video footage of iPads being used in classroom scenarios was suggested to provide teachers with practical ideas on different ways the devices can be deployed. The use of mobile devices can be vastly different to previous technologies used in schools and the use of video could provide exemplar models.

This trial also revealed how students frequently used images, many of which are web-based, to create multimedia artefacts, for example presentations using the Keynote app or Puppet Pals app. Many students involved in the trial conducted searches within Google Images for required images and were adept at copying and pasting images from the Internet, into a chosen app. However, the students did not seek copyright-free images nor did they cite the source of the image. Therefore, students need to develop an awareness of copyright regulations as they relate to digital images. There is an urgent need for teacher professional learning related to copyright regulations to ensure that teachers are equipped with the necessary information to teach students about legally accessing, downloading and using digital material. Given the complexity of this topic, teachers need access to accurate information about what can and cannot be copied and disseminated in a digital setting. Presently, there is an abundance of information on copyright on the TaLE website. A search revealed that there are 3781 resources that match the search term 'copyright'. Two resources worthy of consideration are Sites2See: Copyright for students and Copyright in the Digital World.

Conclusion

This trial has exemplified the benefits associated with using iPads in classroom settings. The iPad encouraged a shift towards a student-centred, personalised learning environment. This emergent technological device, in conjunction with the sound pedagogical frameworks they were embedded in, enhanced students' engagement and motivation, and improved their learning outcomes and attitudes towards learning. Students were able to demonstrate their understanding in various multimodal forms and produced work that was indicative of their true ability. As with any technological innovation implemented in a school context, it is the role of the teacher that is central to its success. As this study has exemplified, teachers play a critical role in aligning the curriculum, pedagogy and technology through the design and implementation of authentic and engaging learning experiences.

While many of the findings related to pedagogy, teacher planning and preparation and student learning can be extrapolated to other touch or mobile devices, many are unique to the iPad and its inherent features. Specific technical and logistical considerations have been elucidated in this trial and must be carefully considered before any implementation.

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This trial study has been supported by a number of key people who were instrumental in the trial project. The teachers and students from the three trial schools are acknowledged for their involvement. The participating teachers and principals undertook all the necessary arrangements to allow CLIC staff members and the external evaluator to observe lessons, conduct interviews and surveys. This was undertaken with goodwill and enthusiasm by all involved. The teachers generously gave their time at a notoriously busy time of the year.

In particular, Sydney Region staff are acknowledged for their efforts in ensuring this trial was a success. They spent countless hours working with the teachers involved in the trial seeking technical solutions to problems that arose. The Technology Advisors, Stu Hasic and Greg Sharkey, and the Technology for Learning Administrator, Robert Pucillo, worked with gusto to ensure the technical issues were promptly resolved. Steve King from Apple Education Australia also provided some technical assistance for the iPads operating within the DEC environment. Lena Arena, the Project co-ordinator and Ariane Skapetis, the ICT Consultant for Sydney Region worked to ensure the design and implementation of the trial was successful. Stephen Sergis and Diane Read, the CLIC staff members representing the Next Practice Unit, collaborated with Sydney Region and acted as a conduit between the schools, the Sydney Region and the external evaluator.

Finally, the students who participated in the trial are commended for their candid responses regarding their thoughts about learning with iPads. The students willingly shared their ideas and provided copies of their work to the CLIC staff members and the external evaluator.

Appendices

Appendix 1: Children's Safe and Educational Use of Mobile and Touch Devices: Parent Information Sheet

Mobile and touch screen devices have caused a revolution in mobile media, changing the lives of adults and now children of all ages who are using these devices. New forms of digital media are influencing children and their families in Australia. Smartphones and touch screen devices like iPads, and tablet devices allow children to play games, access Internet sites, view videos and communicate with peers and a whole lot more.

Safety Tips

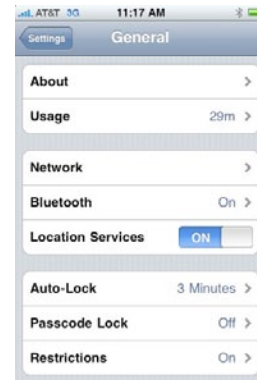
Where possible, parents are encouraged to sit with their children while they use mobile devices. This acts as a safety measure and also encourages children to share and discuss their work with parents, presenting a unique opportunity for parents to extend their children's learning. It is understood that this may not always be possible so parents are encouraged to set parental controls on their devices to prevent their children from accessing inappropriate material.

Setting parental controls on Apple Products

As an internet enabled device, you do not want your child to access inappropriate content on iPads, iPhones or iPods. To limit what your child can access on these devices, you need to set up Parental Controls on each device. The steps required are listed below.



1. From the home screen, select Settings -> General



2. Select Restrictions



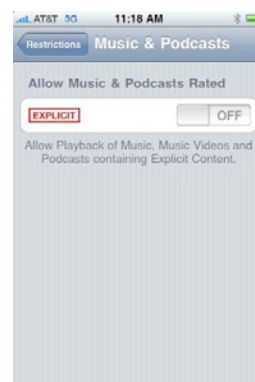
3. You will be prompted to enter a 4 digit password. Remember this as you will need to use it to change any restrictions you set.



4. Set restrictions for Safari, YouTube, iTunes and installing apps.



5. Scroll down to the 'allowed content' section and disable 'In-App Purchases' to prevent your child from making additional purchases through iTunes.



6. Select Music & Podcasts. Set Explicit to 'off'.



7. Specify the restrictions for Movies, TV Shows and Apps.

Screen Time Limits

There are concerns that children spend too much time 'plugged in' and that this is having adverse effects on their development. Current recommendations pertaining to screen time limits are based on research conducted with passive media like television and DVDs. There is no research, as yet, to indicate if and how much time, young children should spend with interactive digital media. The current recommendations are based on guidelines established by the American Academy of Pediatrics (AAP) and are supported by the Australian Communications and Media Authority.

The AAP guidelines state that children under 2 years of age should have no screen time where possible. This is based on current understandings about children's early brain development, the best ways to help them learn, and the effects that various types of stimulation and activities have on this process. Children aged 2 to 5 years, screen time should be limited to no more than 1 hour per day of quality media. For children aged five and above, screen time should be limited to 1 to 2 hours per day of quality media. These recommendations refer to all digital media, including television, DVDs, gaming consoles like Wii and X-Box, iPads, iPods, iPhones and computers.

Tips for Maximising the Use of Mobile Devices

- Make your children aware of how much screen time limit they are limited to each day.
- Encourage your children to identify any TV programs they would like to watch in the TV guide and turn the TV off when their show is finished.

- Record favourite shows and watch later, as this can reduce the amount of time spent watching advertising.
- Encourage your child to plan how they will use their screen time each day.
- Make children's bedrooms 'screen free zones'. Move all screen media into common living areas of the house, where possible.
- Ask your child to share what they have created on the mobile or touch device. Children love to show parents how they have created something on a device. This also keeps parents informed of what types of activities their child is undertaking.
- Where possible, co-viewing is encouraged when using mobile devices. There is emerging research that shows that co-viewing actually promotes learning with digital media.
- Supervise your child when they use the internet.

Selecting Apps

Many parents seek educational content for their children to use on mobile platforms, but it is often overwhelming to find quality material, given that there are so many products marketed as 'educational'. Some important dimensions to consider when selecting an app include:

- Is it interactive?
- Is it adaptive? Can it adjust the level of difficulty in response to the user's needs?
- Does it provide communication opportunities? Can children discuss what they have produced or encountered?
- Is it creative? Are there opportunities for the user to make something or contribute to the experience somehow?
- Does it offer feedback? Many game apps provide instant feedback so the user knows instantaneously if their answer is correct.
- Does it allow user control? Can the user change elements of the activity such as the rate or sequences of actions, the outcome or the primary action itself?
- Carefully consider the reviews provided in iTunes before purchasing the app. There is no stringent process to mediate who posts reviews, meaning that friends of developers can post glowing reviews and therefore limit the credibility of the reviews. However, if there are multiple reviews criticising the app, it is likely that these may be justified. Proceed with caution.
- Always download the 'lite' version, if possible, before purchasing an app. It will have limited functionality (for example, you may not be able to save work or you might receive a limited number of games or pages in a bookapp), but you will get a sense of whether the app is suitable for your child.
- Use a variety of apps: book apps, game apps and creative apps.

It is important that children have the opportunity to create content with mobile media devices (for example, completing online drawings, making music and videos and creating stories) and not just consume media (for example, watching videos, playing games). Whilst games can provide rich opportunities for learning, particularly for skills and content that needs to be memorised (such as

multiplication tables and spelling lists), children's use of mobile and touch devices should not be restricted to these types of apps. When children create content, they use higher order thinking skills and this is strongly encouraged.

Children are encouraged to use apps to create movies about important family events and celebrations, take photographs of special events, make artworks they can email to relatives, create posters and cards they can send to family members and create their own digital stories or online tutorials. Provide your child with opportunities to discover creative things they can do with an iPad. You may be surprised (and delighted) with what they produce!

It is beyond the scope of this Information Sheet to list the names of specific apps that parents should download. However, there are many wonderful websites dedicated to providing thorough reviews of children's and educational apps. Many of these reviewers are parents who recognise the need for quality apps for children and take the time to share their knowledge and insight as a service to other parents.

iPadapps4kids: <http://www.ipadapps4kids.eu/>

Apps4moms: <http://apps4moms.net/wordpress/?p=453>

Momswithapps: <http://momswithapps.com/>

Appendix 2: Websites for Teachers Using iPads

Organisation Name	URL	Brief Summary
Victorian iPad Trial	http://www.ipadsforeducation.vic.edu.au/education-apps	A list of apps used throughout the trial period and information pertaining to the implementation of iPads in primary and secondary schools.
Northern Territory Cloud iPad Trial	http://ntipadtrial.org/trial/	Lists of suggested apps, particularly for students with learning difficulties. Details of trials conducted in secondary schools.
Blooming iPads	http://kathyschrock.net/ipadblooms/	A matrix of apps developed by Kathy Schrock, a technology consultant, according to Bloom's taxonomy. This is an excellent starting point for teachers using iPads.
Redlands Trial	https://ipad.redlands.qld.edu.au/content/apps-0	A list of apps used throughout the trial period and information pertaining to the implementation of iPads in Redlands, a Queensland secondary school.
APPitic	http://appitic.com/	An online database of apps according to curriculum areas.
A Matter of App	http://childrensappreview.blogspot.com/	A website is ideal for K–2 teachers using iPads as it is a review of educational apps, developed by an academic and expert in children's media.
Parramatta Diocese iPad Trial	http://learningwithipads.blogspot.com/p/apps-for-education.html	A blog dedicated to an iPad trial conducted in 2010 with 15 primary and secondary schools in Sydney.
iPad Academy	http://ipadacademy.com/category/collections-compilations	A collection of video tutorials on how to use an iPad and a database on how to locate educational apps.
Apps in Education	http://appsineducation.blogspot.com/	A list of apps by curriculum area and up-to-date posts about iPads by a NSW teacher
Bloom's Taxonomy of Apps	http://issuu.com/ktenkely/docs/lg_alpha?mode=window&backgroundColor=%23222222	An online collection of apps organised according to Bloom's Taxonomy

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image courtesy Joey Alaiza



image courtesy Joey Alaiza



image courtesy Joey Alaiza



image courtesy Joey Alaiza

Let's start again



9:41 AM

iPad 3G

What's the Ultimate Goal?



To have a set of however many iPads for use in class, each of which has all of the desired apps legally installed, with access to wireless internet and an ability to transfer work off and to be ready for use whenever anybody needs one.

...and WHY???

“iPad is a Consumer Device.”

- *When you get frustrated with how the iPads work in a shared environment, remember that you are shoe-horning a device that’s designed for a single user into a shared classroom setup.*
- There will be sharing issues, and until Apple addresses them, you will have to work around the issues.

Things to consider

- *App licencing and deployment*
- *Wireless access*
- *Sharing and saving work*
- *Ongoing maintenance*

An iPad is shown from a front-facing perspective. The screen is black with the word "Apps." written in white, centered. The iPad's status bar is visible at the top of the screen, showing "iPad 3G" on the left, "9:41 AM" in the center, and a battery icon on the right. The iPad has a white bezel and a circular home button on the right side.

Apps.

App Store Terms & Conditions

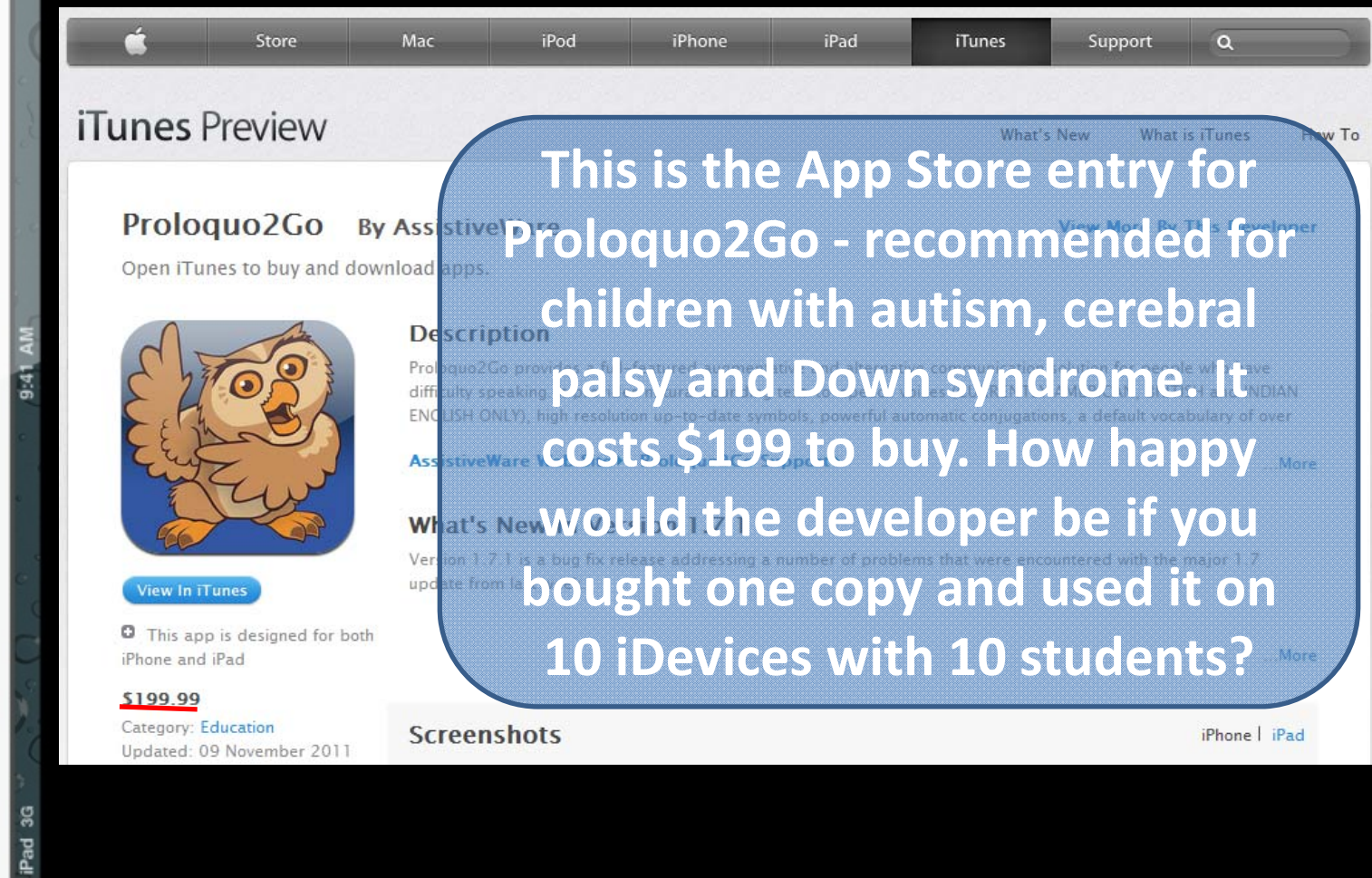
APP STORE PRODUCT USAGE RULES

(i) If you are an individual acting in your personal capacity, you may download and sync an App Store Product for personal, noncommercial use on any iOS Device you own or control.

(ii) If you are a commercial enterprise or educational institution, you may download and sync an App Store Product for use by either (a) a single individual on one or more iOS Devices used by that individual that you own or control or (b) multiple individuals, on a single shared iOS Device you own or control. For example, a single employee may use an App Store Product on both the employee's iPhone and iPad, or multiple students may serially use an App Store Product on a single iPad located at a resource center or library. For the sake of clarity, each iOS Device used serially by multiple users requires a separate license.

There is a misconception that it is OK in a school to use one iTunes Account to buy as many apps as you like and sync those apps to as many iPads or iPod Touches as you like. There is another misconception that you can sync up to 5 iDevices legally. In a school, you simply cannot. Some think, *"Oh, but the Apps are only \$1.99 each. They won't mind. We're a school."*

Still Unsure of Licencing?



This is the App Store entry for Proloquo2Go - recommended for children with autism, cerebral palsy and Down syndrome. It costs \$199 to buy. How happy would the developer be if you bought one copy and used it on 10 iDevices with 10 students?

Some Apple iPad Facts

You'd like that app on every one of your iPads?

In a school, you **MUST** have a **SEPARATE, UNIQUE** Apple iTunes Account for each of your iPads.

You **MUST** purchase **EACH** app for **EACH** account / iPad.



Some Apple iPad Facts



Before you can create an iTunes account, you need an email address. To create a second iTunes account, you need a second, different email address. To create a 15th iTunes account, you need a 15th different email address. Getting the necessary email addresses can be a big problem.

Some Apple iPad Facts

For paid apps, you will need either a credit card number against each iTunes account (*not recommended*), or purchase a SEPARATE iTunes Gift Card for EACH iTunes account.

Buying multiple Gift Cards can be a problem.



Getting Started

1. Consider your Naming convention. What will you call your iPads? In Sydney Region's Trial, we called them SRiPad01 through SRiPad75

3. Create unique email accounts for each iPad using GMail, YahooMail or Hotmail etc. eg. SRipad01@gmail.com

2. Label all your iPads clearly with their names. We used Brother stick-on labels

4. Create individual iTunes accounts WITHOUT a credit card. Instructions here:

<http://support.apple.com/kb/ht2534>

Getting or Buying Apps

5. Dedicate one computer (PC/Mac) to host the separate iTunes Libraries for each iPad. Install the latest version of iTunes

6. Start iTunes while holding down SHIFT key (Win) or OPTION key (Mac)

7. Create a new unique Library named after the first iPad, then apply the first Gift Card

8. Purchase all desired apps directly in iTunes and apply them to the iTunes account. When done, plug in the iPad and sync the purchased apps

Managing Multiple iPad Libraries on one Computer



Hold down SHIFT when starting iTunes



Hold down OPTION when starting iTunes



Wouldn't it be nice...

App Store Volume Purchase Program

The App Store Volume Purchase Program allows educational institutions to purchase iOS apps in volume and distribute the apps to their users.

Program Benefits

With the App Store Volume Purchase Program, your educational institution can buy iOS apps in volume using a Volume Voucher, credit card, or PCard, then distribute the apps to multiple devices.* If your institution is tax exempt, you will not be charged sales tax when you purchase apps. The program also allows app developers to offer special pricing for purchases of 20 apps or more.

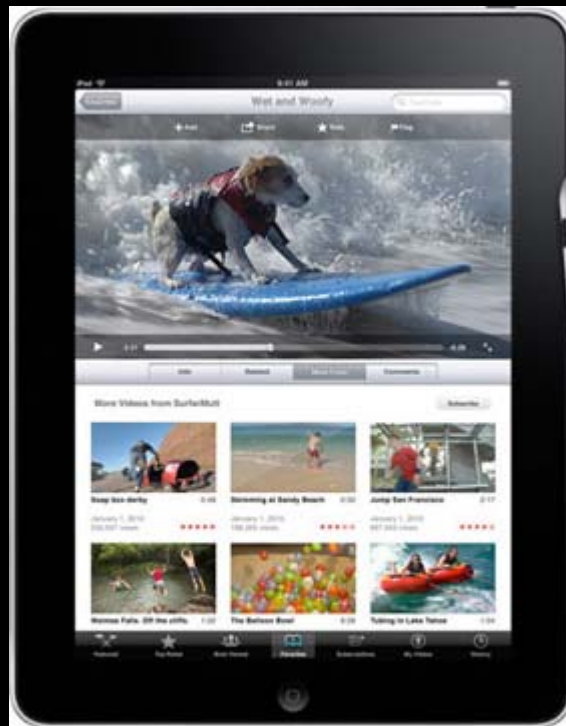


IF THIS WERE AVAILABLE IN AUSTRALIA TOO?

An iPad is shown from a front-facing perspective. The screen is black with the word "Wireless." written in white, sans-serif font in the center. The iPad's status bar is visible at the top of the screen, showing "iPad 3G" on the left, "9:41 AM" in the center, and a battery icon on the right. The iPad has a white bezel and a circular home button on the right side.

Wireless.

Wi-Fi iPad at School

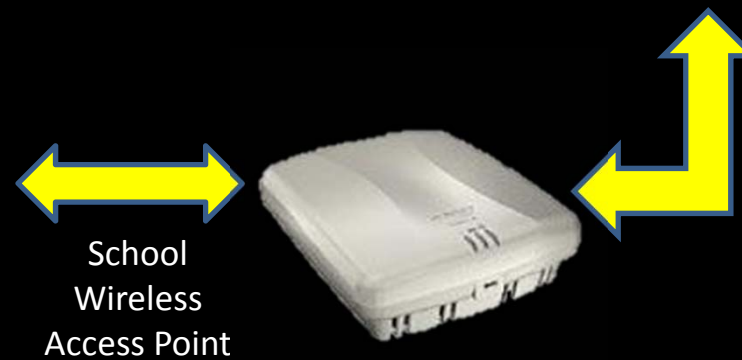


Wi-Fi model

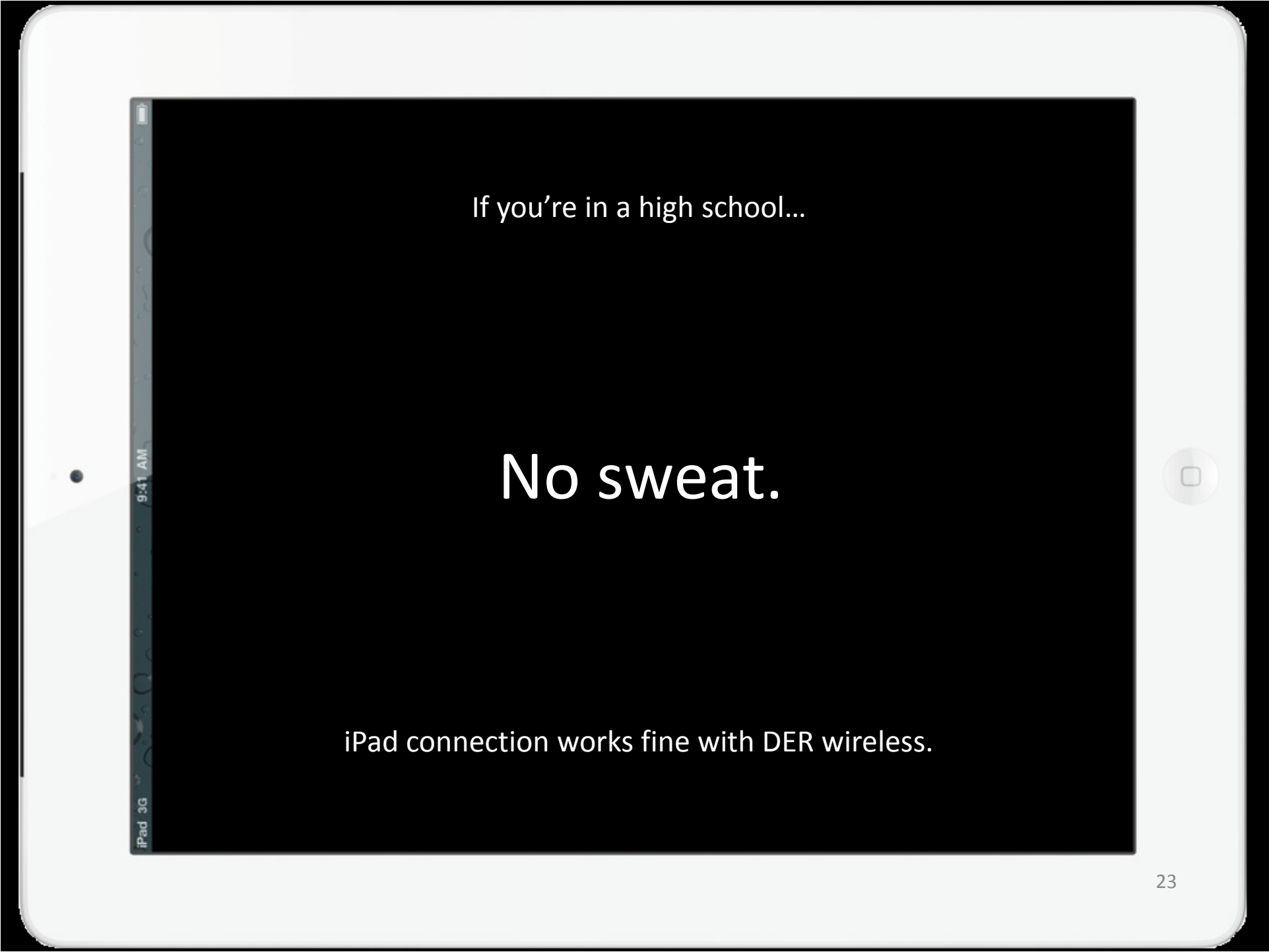


DEC Authenticated Proxy/Filter

School's Cisco Router



School
Wireless
Access Point



If you're in a high school...

No sweat.

iPad connection works fine with DER wireless.

SR Supported Wireless Access Points



**HP Procurve
MSM 410 with
Power Injector.**

Used for portable situations
where the access point
moves with the iPads.



Aruba IAP-105.

Used in fixed situations
Where wireless access
is needed across
a wider number
of rooms.

For either of these, please ask for advice before buying.

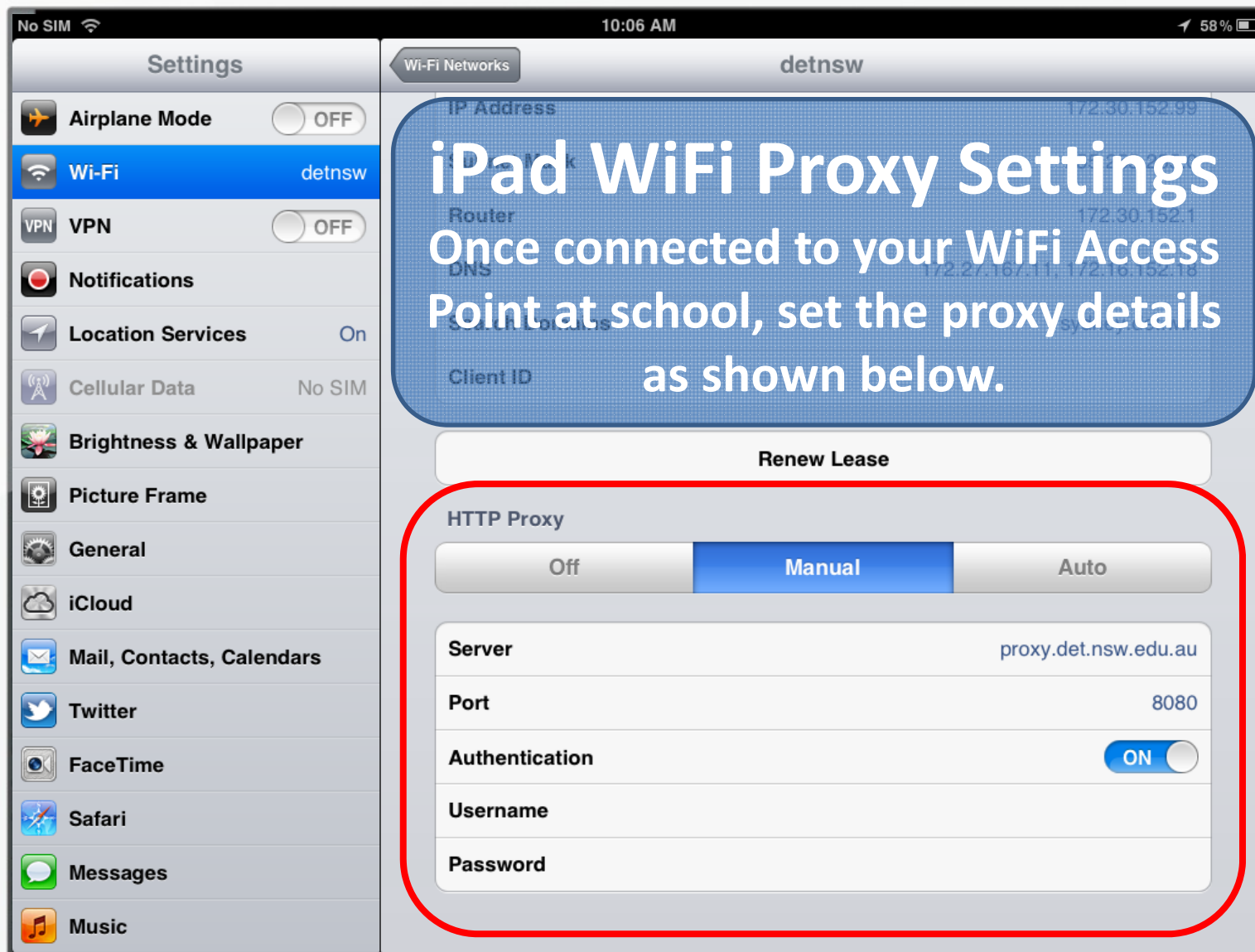
What you shouldn't get




Any Wireless ROUTER.

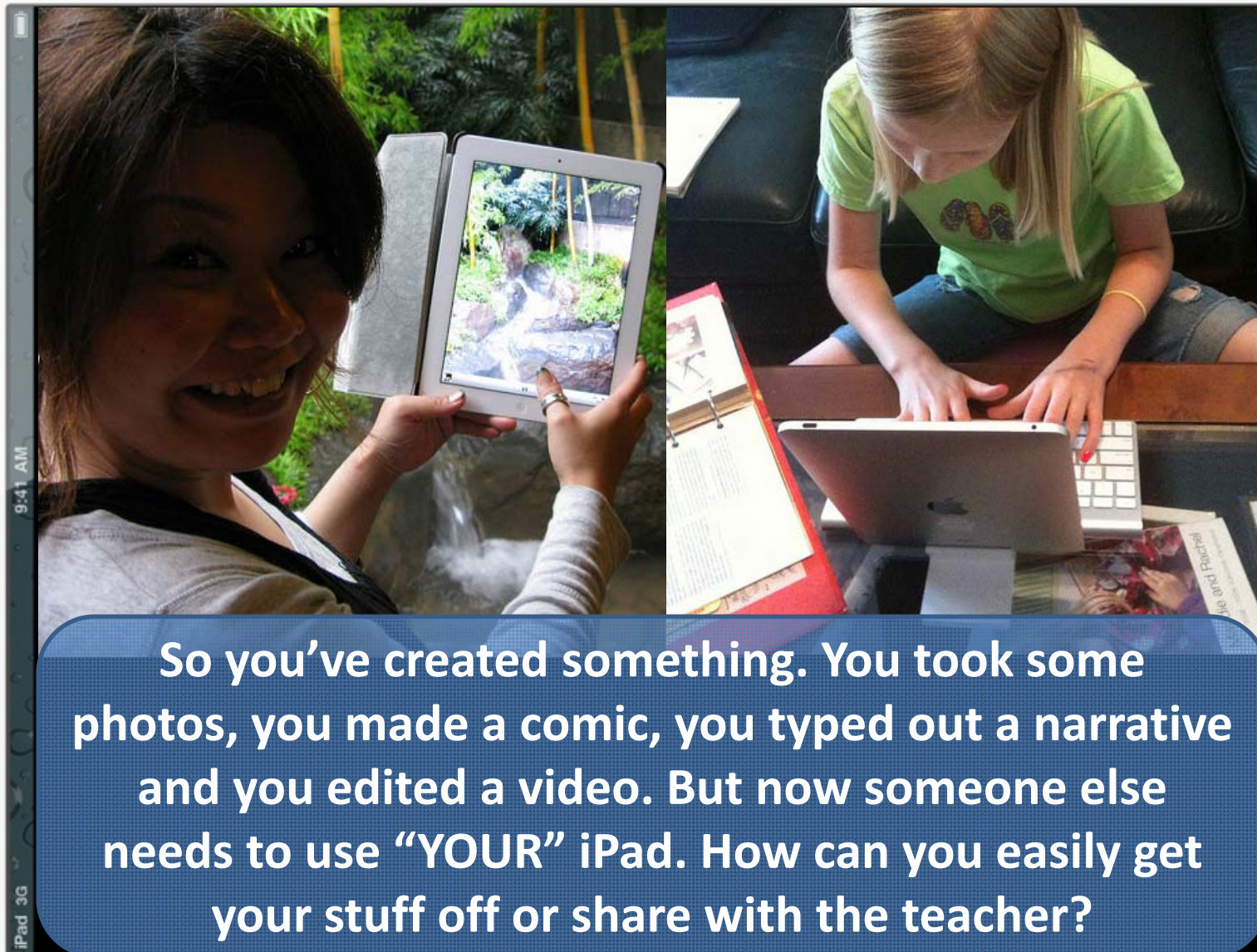
These are designed for home use.
Your school already has a really important router.
Plugging another one into your school's network
can stuff things up. Please DON'T.

Remember, if you need wireless, please ask for advice before buying.





Sharing and
saving work.



Sharing your work on a big screen



A good option to allow students to display their work for the rest of the class.

Apple iPad VGA Adaptor





Email your work.

As long as your apps allow it, then emailing your work is the easiest option. In a shared setup, use this guide

<http://tinyurl.com/ipadmailout>

An iPad is shown from a front-facing perspective. The screen is black with the word "Maintenance." written in white, sans-serif font in the center. The iPad's status bar is visible at the top of the screen, showing "iPad 3G" on the left, "9:41 AM" in the center, and a battery icon on the right. The iPad has a white bezel and a circular home button on the right side.

Maintenance.

Keep your iPads protected.

When buying your iPads, factor in the cost of covers and even thin-film screen protectors. If you want to prolong the life of your iPads, these are essential.





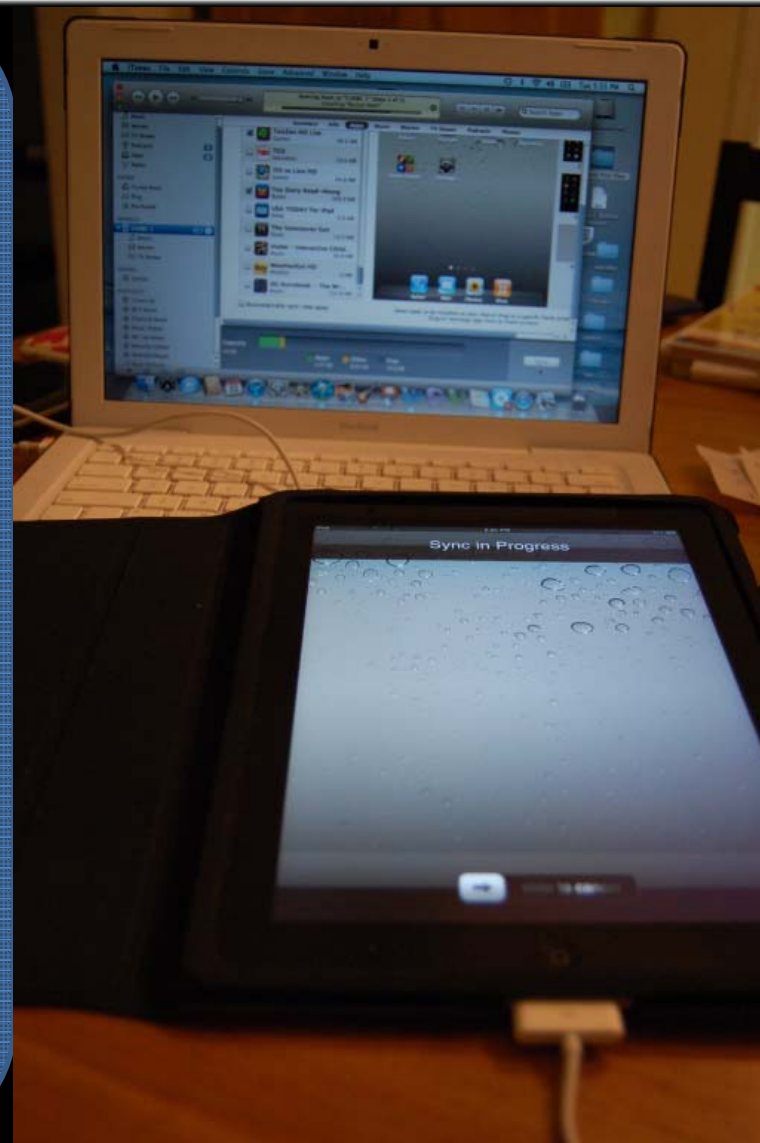
Charging the Battery



To prolong the in-built battery's life, it's best to only put the iPad to charge when it needs it. You should get about two school days' worth of use before it needs charging. Wait till the indicator is below 10% before charging. Even at 10%, you should still get about an hour of use. Always allow it to FULLY charge – it will take several hours to do.

Syncing the iPads

It's very important to regularly sync each iPad back to its host iTunes Library. This will make a backup of all apps and data and allow for easy recovery in case there is a problem. Especially important prior to updates to the iOS.



Syncing Stations

Technically, you can use a syncing station to make all iPads the same, as long as you have legally bought all apps against separate iTunes accounts. Then, be aware that all iPads will have the same name and all will have user data wiped every time you resync. You will need an Apple computer to sync multiple iPads at the same time.



iOS 5



Upgrading to iOS5

This is a highly recommended update, but its installation is not a trivial matter. Sydney Region IT Services have worked out an offline install process which brings the timeframe down to about 15 minutes each (after a sync backup) . Otherwise it's an 800MB download per iPad. Contact us for more details on this procedure.

An iPad is shown from a front-facing perspective, displaying a presentation slide. The slide has a black background with the text "Known Issues." in white, centered. The iPad's status bar at the top left shows "iPad 3G", "9:41 AM", and a battery icon. The iPad's home button is visible on the right side of the bezel.

Known Issues.

It's not there. Live without it.



image courtesy @billamend

Which iOS?



=



Almost all Apps that require Internet will not work with our proxy



=



Most Apps that require Internet will work with DEC's Authenticated Proxy



IPAD PRINTING

Problem solved.

Actually, there are other ways to allow for printing from iPads, but it usually requires dedicated hardware such as special model printers or software running on computers.

Sharing iPads means sharing your stuff



Pages



Keynote



Photos



ComicLife



Mail



Facebook

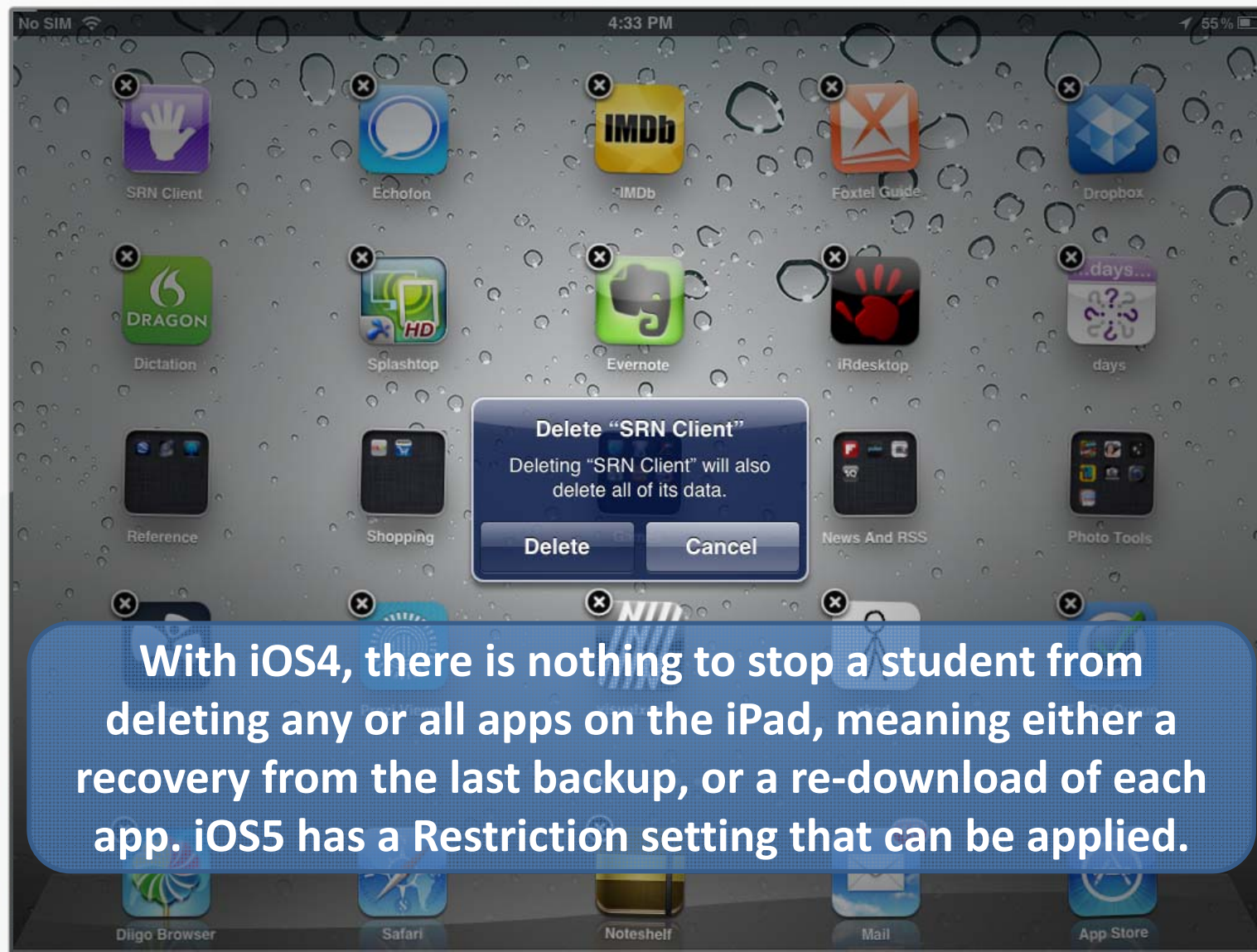


Twitter



Videos

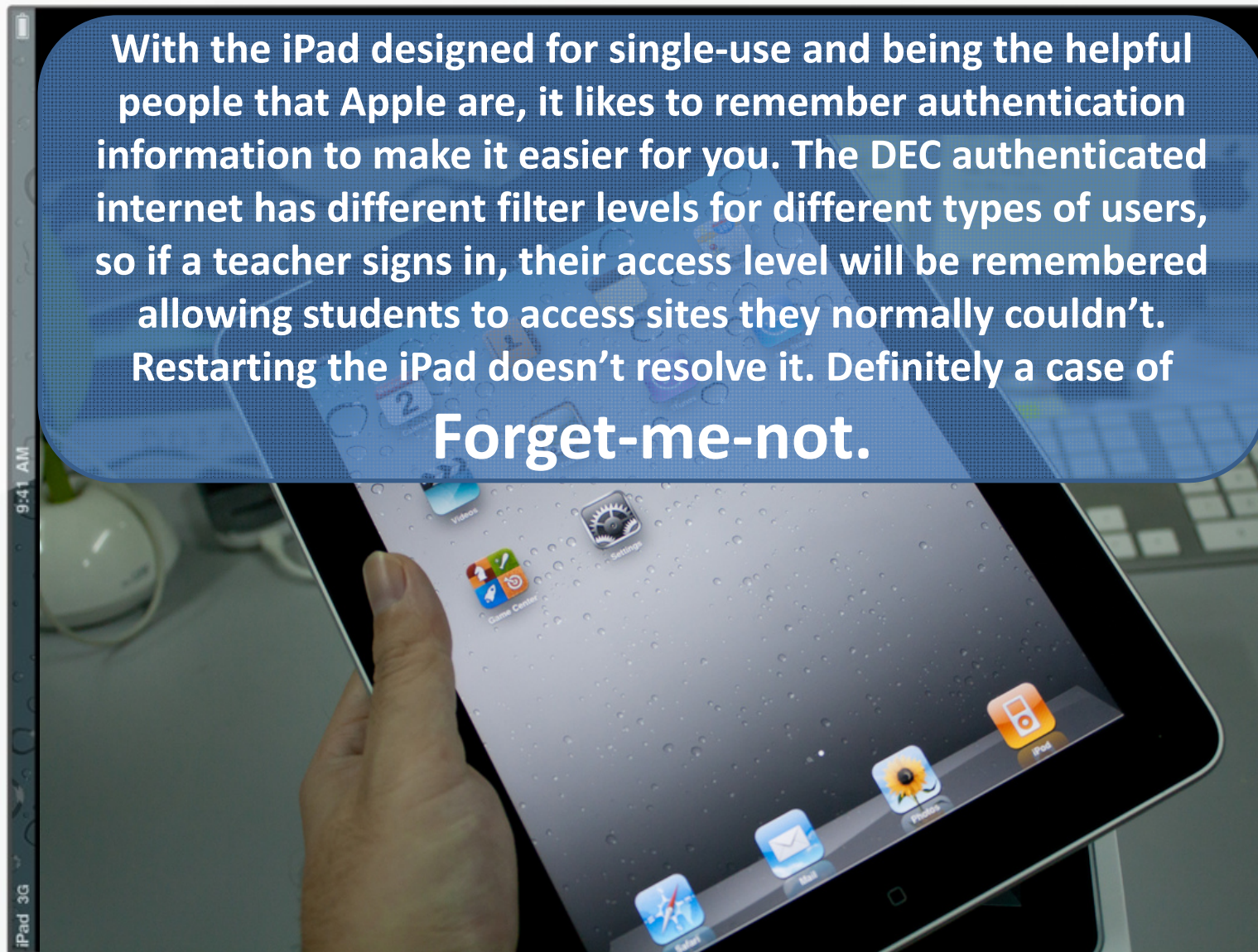
Plus every other app that you put your own work into



With iOS4, there is nothing to stop a student from deleting any or all apps on the iPad, meaning either a recovery from the last backup, or a re-download of each app. iOS5 has a Restriction setting that can be applied.

With the iPad designed for single-use and being the helpful people that Apple are, it likes to remember authentication information to make it easier for you. The DEC authenticated internet has different filter levels for different types of users, so if a teacher signs in, their access level will be remembered allowing students to access sites they normally couldn't. Restarting the iPad doesn't resolve it. Definitely a case of

Forget-me-not.

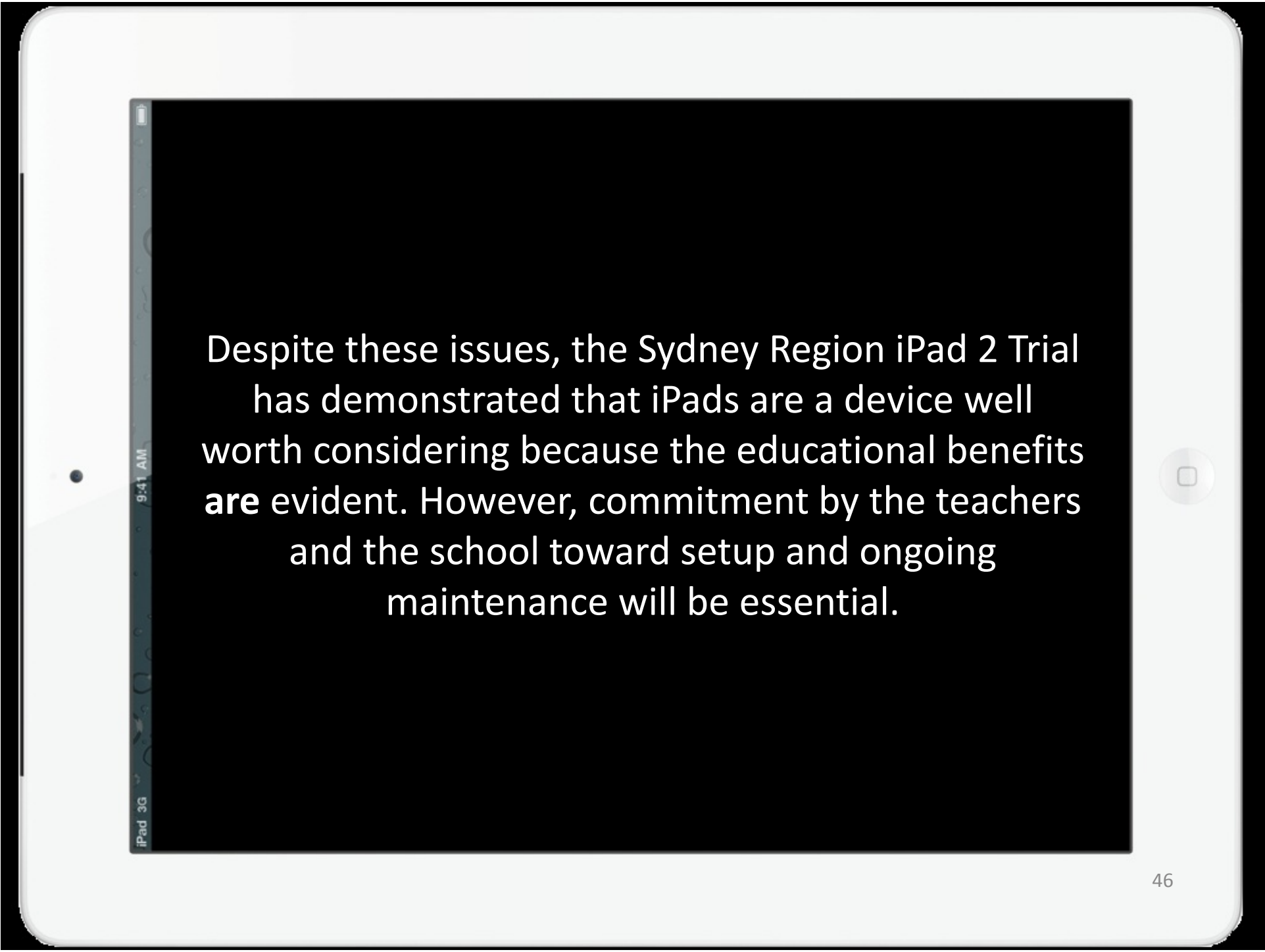


DEC iPad Technical Support

Unfortunately, aside from the Sydney Region iPad Trial, iPads are not currently a supported product in NSW DEC.



image courtesy Faraz Rahnemay

An iPad 2 is shown from a front-facing perspective. The screen displays a presentation slide with a black background and white text. The text reads: "Despite these issues, the Sydney Region iPad 2 Trial has demonstrated that iPads are a device well worth considering because the educational benefits **are** evident. However, commitment by the teachers and the school toward setup and ongoing maintenance will be essential." The iPad's status bar at the top left shows the time "9:41 AM" and "iPad 3G". The home button is visible on the right side of the device.

Despite these issues, the Sydney Region iPad 2 Trial has demonstrated that iPads are a device well worth considering because the educational benefits **are** evident. However, commitment by the teachers and the school toward setup and ongoing maintenance will be essential.

The Sydney Region iPad2 Trial Acknowledgements

- Banksmeadow Public School
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- Apple Australia